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NOTES FROM THE BIOLOGICAL LABORATORY.

EDITED BY PROFESSOR W. K. BROOKS, PH. D., LL. D.

LYELL AND LAMARCK; A CONSIDERATION FOR LAMARCKIANS.

An examination of Romanes' View of "Characters as Hereditary and Acquired."

[Reprinted from *Natural Science*, February, 1896.]

By W. K. BROOKS.

I am much surprised to find my name in Romanes' list (Post-Darwinian Questions, American Edition, p. 14) of "the most prominent American Representatives" of the Neo-Lamarckian School, since I know of no reason for assigning this prominence to me except that I am an American.

I trust, however, that, in order to define my position, I may be permitted to say that I studied the first edition of the *Origin of Species* with intense interest, and that I have been from that time an ardent disciple of Darwin, so far as his great law of selection is concerned; although I read at the same time the examination of the views of Lamarck in the *Principles of Geology*, and was thus convinced that, while natural selection may possibly be no more than a *great but not the exclusive means* of adaptive modification, there is no evidence that the "Lamarckian principles" are among the other means for securing this result.

As none of the modern Lamarckians seem to me to have answered Lyell's argument, I have seen no reason for changing my opinion. As this was formed years before the publication of Weismann's speculations, his *a priori* objection to the possible inheritance of "acquired characters" has not influenced me, since I have learned from Lyell that there is another question at issue—a question more fundamental and important than the question of their inheritance or non-inheritance.

In order to illustrate this I propose to examine Romanes' opinion that, if the inheritance of the influence of nurture is "in any degree operative at all, the great function of these (Lamarckian) principles must be that of supplying to natural selection these incipient stages of adaptive modification, in all cases where, but for this agency, there would be nothing of the kind to select." (Page 153 American Edition).

Unless these "factors" can be proved to have this "function" they are unworthy of consideration as a contribution to the history of adaptive modification; and I, for one, have found little to interest me in the interminable dispute as to the inheritance or non-inheritance of the effects of the conditions of life, because my study of Lyell taught me, long ago, that the gist of the whole matter is the deeper question whether these effects are inherently adaptive.

Lyell was ignorant of the principle of selection when he wrote the first edition of the *Principles*; but to us, who know the value of this adaptive

mechanism, the question narrows down to the evidence that the "Lamarckian factors" can give rise to even "the incipient stages of adaptive modification."

As the strengthening of muscles by exercise is one of the simplest examples of the beneficial effect of the conditions of life, we may find instruction in its attentive consideration.

In the strict sense of the words, it is not use, but increase in the food-supply, which enlarges the muscle, and this increase may be brought about by massage or by electrical stimulation as well as by exercise. Contractions and relaxations of the muscle increase the supply of food, because the muscle is so constructed that the nutritive fluids are drawn through it, in the right direction, by its normal contractions. The improvement of the muscle by exercise is the effect of a structural adjustment for securing this useful end—it is an adaptation; and the muscle is as obviously, if not as definitely, adapted for improvement by use as the heart is adapted for propelling blood.

Exercise increases its efficiency only so far as structural adjustments for bringing this about already exist, and the real problem, the origin of the adaptation, is in no way different from that presented by any other structural adaptation.

This is still farther illustrated by the fact that organs are improved only by normal or natural use, while abnormal or unnatural use is well called abuse, as contrasted with use. It is only when our organs are used in that way which is popularly described as "the way in which they were intended to be used," that use is beneficial.

Romanes tells us, p. 59: "Inasmuch as we know to what a wonderful extent adaptive modifications are secured, during individual lifetime, by the direct action of the environment on the one hand, and by increased or diminished use of special organs and mental faculties on the other, it becomes obvious of what importance, even a small measure of transmissibility on their part, would be in furnishing to natural selection ready made variations in required directions, as distinguished from promiscuous variations in all directions. Contrariwise, if functionally produced adaptations and adaptations by the direct action of the environment are never transmitted in any degree . . . there would be an incalculable waste, so to speak, of adaptive modifications."

This argument has seemed, to many persons, a plausible one, but it is clear that it involves a most serious fallacy, unless the inheritance of the effect of the "Lamarckian principles" can be proved to be selective; for the ways to use a muscle are few, while the ways to abuse it are innumerable, and the inheritance of *all* the effects of the conditions of life must lead, not to "cumulative adaptation," but to cumulative destruction.



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Unless these factors can be shown to have, antecedently to selection, a determinate influence in beneficial lines, it seems to be, on the whole, rather fortunate than otherwise that evidence of the inheritance of their effects is so hard to find.

Now is there any ground for the belief that the case is any different with intellectual and moral improvement? All known mental phenomena have structural correlatives, and are capable of development and improvement only so far as structural adjustments for bringing about this development and improvement already exist. Capacity for individual improvement under the normal conditions of life is an adaptation; the most wonderful and admirable of adaptations; and the beneficial influence of the "Lamarckian factors," so far as this influence is beneficial, is not an explanation, but a fact which itself calls for explanation.

Is there any evidence that the influence of the environment is inherently beneficial? If there is no such evidence we must believe that all its effects, except the effects which are already deducible from adaptive structure, must be hap-hazard.

When we remember how narrow the range of adjustment of each organism is, it must be clear that the probability that hap-hazard effects will be injurious or neutral rather than beneficial is prodigious. Even if they are inherited, the effects of the "Lamarckian principles" cannot cumulate in adaptation, except as an accident which is so improbable that we are justified in doubting whether it has given rise to any specified adaptation until the possibility of a better explanation has been rigorously excluded.

While I find a difficulty in reconciling all Romanes' published opinions on this subject with each other, he seems to hold, p. 153, that "These Lamarckian principles are direct causes of determinate variation in adaptive lines," although it is clear that this must be proved before we can agree with him that "variation in these lines being cumulative, the result is that natural selection is in large part presented with the raw material of its manufacture—special material of the particular kind required, as distinguished from promiscuous material of all kinds."

Some fifteen years ago I published a book in which I sought to prove that we have in sexual reproduction a mechanism, produced by selection, for the purpose of causing changes in parts which need change, and that this mechanism expedites selection. My book found the oblivion which it no doubt deserved, but I suspect that it may have led, in some circuitous way, to the enrollment of my name in the list of New Lamarckians, although I explicitly stated that I did not believe that these changes in parts which need change are adaptive; and I still believe, as I did then, that the "Lamarckian principles" must be proved to be adaptive, antecedently to selection, before we can seriously consider them as factors in adaptive modification.

There is, in Romanes' book, one sentence,—only one so far as I have discovered,—in which he seems to admit that this is not only unproved but disproved. On page 73 he tells us, of the "Lamarckian factors," that "No question of value, as selective or otherwise, can obtain in their case."

If we grant this, as I think we must; if we admit that these "factors" involve "no question of value," but that it is, to say the least, no better than an even chance whether their influence be good, bad or indifferent, how do modifications produced by them differ from "fortuitous variations?"

Those who attribute the opinion that the so-called Lamarckian principles have not yet been proved to be factors in organic evolution, to the influence of Weismann, will do well to remember that we owe to Charles Lyell the demonstration that, until the influence of the conditions of life has been proved to be determinate; until their competency to cause a tendency to progressive development, antecedent to selection, has been made clear; they are of no value whatever as a contribution to the solution of the problems of adaptation.

It is quite possible that, in the long history of living things, adaptive structures have occasionally been produced by the fortuitous coincidence of fortuitous variations; but the chances against this are so overwhelming that we are justified in demanding demonstrative evidence before we accept this explanation of any adaptation.

The production of words and sentences by running type through a hopper is not impossible, but many generations of readers have approved Swift's statement that this method of advancing knowledge failed to produce a single learned treatise.

Since all the past history of life is beyond the reach of experiments, and since the scientific study of domesticated animals and cultivated plants is

very modern, most of the evidence for natural selection is, and must be, indirect or deductive. Romanes holds, p. 57, that, since there seems to him to be the same sort of evidence of the influence of the "Lamarckian factors," these stand upon as good a logical footing, in the explanation of adaptive structures, as selection; but the cases are not parallel, and the sort of evidence which is adequate in the one case is totally inadequate in the other case.

If natural selection acts at all, it must result in adaptation; while the advocates of the "Lamarckian factors" have yet to prove that these "factors" can account for any adaptive structure whatever, incipient or otherwise, except so far as this is the result of pre-existing adaptive machinery.

Satisfactory evidence that an event is the sequence of antecedents which are adequate may be totally unsatisfactory as evidence that it is the sequence of antecedents which seem inadequate. Indirect or deductive evidence may convince us that an adaptation is the result of selection, and may yet be totally unsatisfactory as proof that one is the result of the inheritance of the effect of nurture. Until this factor has been proved to be determinate and adaptive, the proof which we must demand before we can believe that it has produced adaptive modifications is like the proof which would convince us that words and sentences have fallen from a hopper filled with loose type. We must have demonstrative evidence that no undiscovered adaptive mechanism is at work.

Those who hold, with Romanes, that we find in nature structural adjustments which are inexplicable by selection alone, would do well to rest on their oars and look about them for some other determinate factor, or, perhaps, for a better acquaintance with the resources of selection, before they attribute them, without demonstrative evidence, to indeterminate "factors."

LYELL AND LAMARCKISM.

A REPLY TO PROFESSOR W. K. BROOKS.

By J. T. CUNNINGHAM.

[Reprinted from *Natural Science*, May, 1896.]

Professor Brooks, in *Natural Science* for February, p. 89, has informed us that Romanes was mistaken in including him among American Lamarckians, and has at the same time explained why he considers Lamarckism untenable. His reasons do not appear to me adequate, and although I can scarcely hope to induce him to alter his intellectual position, I desire to ask the attention of other biologists to the following criticism of his arguments.

He believes, apparently, that his objections are essentially those expressed by Lyell in his "Principles of Geology," published long before Darwin's theory was made known. It is true that Lyell was unconvinced by Lamarck, but convinced of the truth of evolution by Darwin. Brooks maintains that Lyell's objections to Lamarck's particular views still remain unanswered, and supposes, if I understand him rightly, that his article merely recapitulates and expounds Lyell's arguments. Careful consideration of the article leads me to conclude, first, that Brooks's arguments are not those of Lyell, and, secondly, that they are not sound. I will give my reasons for these conclusions in their order.

According to Professor Brooks, Lyell proved that the effects of the environment were not inherently adaptive, and therefore whether inherited or not, could not be accepted as the cause of the evolution of adaptations. After perusal of Lyell's reply to Lamarck's views in the "Principles of Geology," I fail to find any indication of this proposition. The general tenor of Lyell's argument, as I understand it, is that the environmental forces may and do produce results some of which are adaptive, and which do become hereditary, but that the departure from the specific type so caused is definitely limited; and that the capacity for change within these limits is merely a fixed property of the species, which, like other specific properties, is immutable in its extent. The importance of the question is sufficient justification for quoting in full Lyell's own summary of his arguments. It is as follows:—

1. "There is a capacity in all species to accommodate themselves, to a certain extent, to a change of external circumstances, this extent varying greatly, according to the species.

2. "When the change of situation which they can endure is great, it is usually attended by some modifications of the form, colour, size, structure, or other particulars; but the mutations thus superinduced are governed by constant laws, and the capability of so varying forms part of the permanent specific character.

3. "Some acquired peculiarities of form, structure, and instinct, are transmissible to the offspring; but these consist of such qualities and attributes only as are intimately related to the natural wants and propensities of the species.

4. "The entire variation from the original type, which any given kind of change can produce, may usually be effected in a brief period of time, after which no further deviation can be obtained by continuing to alter the circumstances, though ever so gradually; indefinite divergence, either in the way of improvement or deterioration, being prevented, and the least possible excess beyond the defined limits being fatal to the existence of the individual.

5. "The intermixture of distinct species is guarded against by the aversion of the individuals composing them to sexual union, or by the sterility of the mule offspring. It does not appear that true hybrid races have ever been perpetuated for several generations, even by the assistance of man; for the cases usually cited relate to the crossing of mules with individuals of pure species, and not to the intermixture of hybrid with hybrid.

6. "From the above considerations it appears that species have a real existence in nature; and that each was endowed, at the time of its creation, with the attributes and organization by which it is now distinguished."

I think there can be no dispute, with this summary before us, that Lyell's objection to Lamarck's views was, not that the effects of the environment were non-adaptive, but that they were permanently limited in extent. The doctrine of the fixity and essential immutability of species having been abandoned, as it ultimately was by Lyell, it follows that, in the judgment of both Lyell and Darwin, there was no ultimate limit to the extent of adaptive and hereditary modification that could be produced directly by changes in the environment.

Professor Brooks's arguments having been shown not to have the authority of Lyell, which he claims for them, we will proceed to consider them on their own merits. He takes the case of the strengthening of muscles by exercise, which he admits to be an adaptive, *i. e.*, a beneficial, change in relation to the conditions calling it forth, "one of the simplest examples of the beneficial effects of the conditions of life." But this, he tells us, is not an example of the direct action of the environment on the organism. On the contrary, the increase and improvement of the muscle are due to the increased supply of nourishment produced by exercise; and the fact that exercise causes an increased circulation of blood in the muscle depends upon structural adjustments, which themselves constitute an adaptation, originally, I suppose, due to congenital variation and selection. Now I think it may well be held that the supply of nourishment is not the same thing as assimilation and growth; and the assimilation and growth of the muscle under stimulus must be ascribed to a fundamental property of protoplasm, which it is not the business of Lamarckians or evolutionists of any other school to explain. But, apart from this, let us consider how far back in the phylogeny of vertebrates we must go to find the origin of a circulatory system; and consider that, from this point onwards, if changes in the locomotor system are due to the use and disuse of various parts of this system, and are inherited, then there is practically no limit to the variety and perfection of the adaptations in the locomotor system which can be explained by the Lamarckian factor. If selection produced in the remote ancestor the circulation and the structural arrangement by which muscle (and, of course, bone and other connective tissues and nerves) received increased supplies of blood when exercised, then it would require to produce nothing else to account for such adaptations as the neck of the giraffe, the various arrangements of the toes and limbs in ungulates, the peculiarities of the legs and skeleton in man which enable him to maintain the erect attitude, the form of the pectoral muscles and sternum in flying birds, the absence of the keel on the sternum in ostriches, the peculiarities of the tongue and hyoid bone in woodpeckers, of the beak in crossbills, and thousands of other mechanisms, all consisting in adjustments of muscle, bone, and nerve.

Professor Brooks next proceeds to argue that organs are only improved by normal or natural use, and that only with this limitation is use beneficial. "The ways to use a muscle are few, while the ways to abuse it are innumerable, and the inheritance of *all* the effects of the conditions of life

must lead, not to 'cumulative adaptation,' but to cumulative destruction;" but no Lamarckian supposes that the action of the environment is necessarily beneficial. It would be interesting to know what meaning Professor Brooks attaches to the words "the ways to abuse a muscle are innumerable." To myself they are unintelligible. A muscle can be used, disused, or over-exerted—in fact, there is only one way to use it, and that is to contract it. Excessive strain which does not cause development and increase of the muscle must lead to injury and ultimately to the death of the organism. Disuse leads to degeneration. Degeneration is not necessarily beneficial, but it is included in the conception of adaptation, and it may be beneficial in relation to the adaptation of the whole organism to a new mode of life. The case of a herd of antelopes hunted by carnivores will illustrate the different points of view of the Lamarckian and the selectionist. Certain individuals, we may suppose, are caught and killed, others may escape and die of fatigue or an over-strained heart, while the rest escape and recover their strength. The fact that some are killed is in no way inconsistent with the fact that the survivors are improved with respect to the muscles and bones on which their running powers depend. It may even be that the persecution is so great that the constitutions of the whole herd are injured, their progeny are not sound, or are weaker, and the result is extermination; but the inheritance of *all* the effects of the conditions of life does not always lead to cumulative destruction; if it did, there would be nothing left alive, and the statement that on Lamarckian principles it would, is equivalent to saying that the conditions unfavourable to life are, on the whole, more powerful than those which are favourable, a statement we know to be untrue. What Lamarckians contend is, that the conditions of life kill a large number of individuals and modify those which survive; that the struggle for existence not only involves the survival of the fittest, but the formation of the fittest. Professor Brooks's argument shows that he has quite failed to understand the Lamarckian view, and suggests strongly that he has never tried to do so.

Professor Brooks maintains that the structural changes associated with mental development are also, like the modification of muscles, dependent on structural adjustments for bringing about this development, and that the effects of the environment which are not "already deducible from adaptive structure, must be haphazard." But we are not told what are these other effects of the environment. The effects which are stated by Brooks to be dependent on pre-existing capacities are those which Lamarckians have chiefly in view. The others, it is said, must be haphazard because they are not proved to be beneficial. Now, to take an example, the excessive consumption of alcohol is not beneficial, but are its effects therefore haphazard? It does not follow that because the effect of a given condition is not beneficial, therefore it must be indeterminate. On the contrary, science is founded on the conclusion, drawn from experience, that the same conditions always produce the same effects, and that is all that Lamarckians contend for.

We see, then, that Brooks's objection to Lamarckism, so far as the effects of use and disuse are concerned, is that such effects are due to structural arrangements already existing for the local increase or decrease in the supply of the nutritive fluids, or blood, and that Lamarckism does not explain these structural arrangements. We have seen that, if this objection were valid, Lamarckian effects would explain all the modifications in animals which have taken place since they had a circulation. But we have seen also that the objection is fallacious, because the supply of nourishment does not necessarily imply assimilation and growth, which are the results of stimulation. The effects of a profusion of nourishment and absence of stimulation are sufficiently notorious in the phenomena of parasitism. Is Professor Brooks unaware that Lamarckism extends to plants, and if not can he suggest that the modification of flowers by the irritation due to insects depends on structural arrangements for the supply of nutrient fluids?

Professor Brooks has misinterpreted in the most astonishing manner one statement of Romanes, that "no question of value, as selective or otherwise, can obtain" in the case of Lamarckian factors. He cites this as an admission on the part of Romanes "that it is, to say the least, no better than an even chance whether their influence be good, bad, or indifferent." What Romanes means is that it does not matter how slight the adaptive effects of the conditions may be; if they are inherited at all, they will be present in all the individuals exposed to the conditions, and will be increased in every generation; whereas before a variation can be selected, it must be supposed to have 'selection value'—that is, must be large enough and important enough to give a better chance of life and reproduction to its possessor than

other individuals have. This is one great advantage of the Lamarckian theory, that a character which is constant in a whole species may be explained without assuming that it is either of selective value, or correlated with something of selective value. In fact, the idea of advantage or benefit to the organism belongs essentially to the selectionist view. All that the Lamarckian requires is that certain effects which he sees to be produced in the individual by response of living units to stimulation shall be cumulative, and then the modifications which we know to have occurred must necessarily follow. The effects of stimulation in its widest sense may be life-preserving or life-destroying; the hypothesis is that they are definite and cumulative.

Where the question of chance or fortuitous variations comes in I fail to understand. It is notorious that the selection theory assumes the occurrence of fortuitous variations, although with the understanding that fortuitous means unexplained only. But the assertion that the effects of conditions on the individual, or acquired characters, which alone I have considered in this article, are fortuitous is simply a contradiction of universal experience.

We find, therefore, on careful analysis, that Brooks conceives the effects of environment on the individual to be of two kinds; first, the kind of which the enlargement of a muscle by exercise is an instance, and, secondly, the others. Those of the first kind are due to structural adjustments for bringing them about. According to the Lamarckian view, all adaptations, at any rate all adjustments concerning whose action and efficiency there is no dispute, have arisen in the same way as the enlargement of a muscle by exercise; and the assertion that structural adjustments for rendering them possible exist in organisms is just what Lamarckians contend. Therefore, on this point Brooks agrees with Lamarckians; but whereas he supposes that these structural adjustments have to be explained, Lamarckians believe that they are merely the fundamental properties of protoplasm, namely, irritability and the power of assimilation and reproduction. The 'other' effects of conditions are those which confer no particular benefit on the organism. To take a trivial instance, a young man who takes to an open-air colonial life develops muscles and skeleton and senses to such an extent that he can ride, shoot, and work with marvellous skill and endurance. At the same time his skin is tanned brown by the sun. The former changes are adaptive and beneficial; the latter would not usually be called an adaptation, though it may on investigation be found to be beneficial. It is an instance of the 'other effects' of the environment, and is obviously not haphazard, but definite and constant. Brooks asks if there is any evidence that the effects of the environment are inherently beneficial, and the reply is shown by the above considerations to be that, whether beneficial or not, the same conditions acting constantly produce a definite effect. We are here considering, not congenital variations—those which, like a supernumerary digit, arise in a single individual without obvious relation to the conditions of life—but exclusively the effect of external conditions on the individual during life.

Brooks thinks that natural selection, if it act at all, must result in adaptation, and that therefore it is a much more plausible theory than the Lamarckian. But this is begging the question: natural selection means the survival of adaptive variations, and the question is the origin and cause of such variations. Lamarckians do not admit that such variations have been proved to occur without the direct action of the conditions of life; therefore to assert that natural selection must produce adaptation is to assume the very proposition in dispute. Even if it were proved that the variations were independent of the conditions of life, the mere selection of them in itself would not be an explanation; we should still want to know the true causes of them.

LYELL.

By W. K. BROOKS.

If the author of "Lyell and Lamarckism; a Reply to Professor W. K. Brooks" (*Natural Science*, May, 1896), means, by the words "an explanation," on page 331, a complete and ultimate explanation, I fully agree with him that, in this sense of the words, natural selection is no explanation of the attributes of living things, and that, "we should still want to know the true causes of them," although the fact that we "want to know" is no evidence that we ever shall know the true cause, *vera causa*, of anything.

Explanations, although imperfect, may still be valuable, even if we are never to find out "that which produceth a thing and maketh it what it is."

If it should ever be proved, as it may for all I know, that the matter which composes the known universe has been sifted out from other forms of matter by its property of weight, gravitation would remain as good an explanation of our 'universe' as it is now, although we should still "want to know" how our particular sort of matter got its weight.

Darwin's work, like all good work in science, is an attempt to find out a little of the *order*, as distinguished from the *true cause*, of nature. It is a highly successful effort to study the history of living things, by means of all available evidence; and, as I understand it, the value of natural selection is quite independent of whatever we may discover or fail to discover, concerning the true cause of that diversity among individuals which has, by an unfortunate use of words, come to be called variation.

The author of the article on "Lyell and Lamarckism" says: "According to the Lamarckian view, all adaptations, at any rate all adjustments concerning whose action and efficacy there is no dispute, having arisen in the 'same way as the enlargement of a muscle by exercise' (p. 330); that is, 'they must be ascribed to a fundamental property of protoplasm' (p. 328); 'and the assertion that structural adjustments for rendering them possible exist in organisms is just what Lamarckians contend. Therefore on this point Brooks agrees with Lamarckians; but whereas he supposes that these 'structural adjustments have to be explained, Lamarckians believe that they 'are merely the fundamental properties of protoplasm' (p. 330).

I am not sure I understand what the writer means by *structural adjustments for rendering adjustments possible*, but I suppose the structural adjustments of the human eye will be admitted as examples of "adjustments concerning whose action and efficacy there is no dispute;" and the writer is quite right in his assertion that "Brooks . . . supposes that these structural adjustments have to be explained," if they can. He might have added that I do not suppose the assertion "that they are merely the fundamental properties of protoplasm," will be generally regarded as an important contribution to the explanation.

As I understand him, the writer believes the attributes of all living things are to be deduced from the properties of living matter; an opinion which I am quite prepared to accept as soon as it is proved; for I most assuredly do not believe anything inconsistent with this creed, except that "the assertion which outstrips evidence is not only a blunder but a crime."

If it is ever proved that the attributes of all the living things which exist and of all those which have existed in the past are deducible from the properties of living matter, I do not see how we can stop here, or refuse to admit that innumerable forms, filling up all the gaps between all the known species, are also deducible from the same properties. We must also admit that this living matter contains the promise and potency of all the monstrosities which have been reared by the breeder or the horticulturalist, and of innumerable abortions, as well as hosts of possible organisms which have, so far, lain dormant in the womb of time, and of which most may never see the light.

The first question concerning the origin of species we have to ask is, why this potency has resulted in a system of nature which is comparable to a tree with diverging branches, and empty spaces, widening as time goes on, between them—instead of a spherical shell of individuals growing outwards in all directions from a common centre.

According to Darwin this is the outcome of a process of extermination, which must lead to this result whether there is or is not an agency which draws out definite combinations from that wonderful Pandora's box, the potency of living matter.

A species consists of a number of similar, but not identical, individuals, grouped about a mean according to the statistical "law of error," and the characteristics of each individual are what the students of statistics call an "event."

According to Darwin the influences which determine each "event" have nothing to do with the character of the type, as this is fixed by the standard of extermination. To the question whether specific types are inherent in living matter or external and objective to it, he answers that they are both; that they are inherent inasmuch as all their data, or "events," are properties of the physical basis of life; but that they are external inasmuch as the agreement of the "events" with the "law of frequency of error" is the effect of the environment.

When embryologists talk about the doctrine of evolution in embryology as antagonistic to the doctrine of epigenesis; when biologists seek for the origin of species in laws of variation which are not the outcome of selection; when they talk about a "principle of organic stability," which does not owe its origin to the same mechanism—it seems to me that they fail to grasp the significance of Darwin's work, and that they are wandering from the only path in which we can have any well-grounded hope for progress; the path which takes its departure in that conception of specific types which leads us to seek for the origin of the "events" which exhibit the type in the structure of living organisms, and to seek in the order of nature external to the organism for the origin of that "law of error" which picks out a type from among these events.

The specific types of the zoölogist and the botanist have peculiar interest since they persist from generation to generation, according to what is known as the law of specific stability; while they also undergo slow changes according to the principle of the mutability of species. In popular language specific stability may be said to be due to inheritance, and specific mutability to variation; but in this connection these words have only a loose meaning, and it has long seemed clear to me that much of the current misconception of Darwin's meaning is due to the fact that, in his desire to make clear the analogy between natural and artificial selection, he borrowed these words from the breeders without due deliberation.

In so far as they give the impression that the stability of species and the mutability of species are antagonistic to each other, that they are due to two distinct and opposing influences, or that the individual which is preserved is a "variation" in any sense which is not equally applicable to the one which is exterminated, these words are unfortunate; for notwithstanding Darwin's words, his context shows clearly that he looks at both the stability and the mutability of species as due to the same influence—the extermination by natural selection of certain individuals, and the preservation of others and their progeny.

While a recent writer in *Natural Science* holds that sexual reproduction is the cause of types, all students of the subject are perfectly familiar with the fact that data drawn from any source, living or dead, may conform to a type, and the excellence of natural selection is not that it explains the existence of types, but that it explains a distinctive peculiarity of the particular sort of types which concern the zoölogist and botanist. These types not only persist from generation to generation, but they also exhibit fitness. It is this fitness, and not mere conformity to the statistical "law of error," which calls for explanation, and gives to biology the rank of an independent science, distinct from the physics and chemistry of the living body. It is in this that we find the great excellence of Darwin's explanation of the origin of species by the extermination of the unfit and the survival of the relatively fit; for he shows that the fitness is determined by the external world and not by any inherent property of fitness in those which are preserved, or of unfitness in those which are weeded out, since a difference in the external world might have reversed the result.

The motive of my own letter on "Lamarck and Lyell," which has called forth this "Reply," was not love of controversy, but a natural desire to protest against the statement, which had appeared in a book, that I am one of the prominent advocates of Lamarckianism.

Since I "have quite failed to understand the Lamarckian view," the author of the "Reply" suspects strongly that I have not tried, though I hope he will credit my assertion that my failure is not due to lack of effort, but to the incompetency of my efforts to bring about the desired result.

My studies seem to show that Lamarckians believe (1) that effort, use and disuse, and the direct action of the conditions of life, are adequate to explain all the phenomena of fitness, and that natural selection is superfluous; (2) that natural selection is useful as a means for preserving what the Lamarckian "factors" supply, but that it originates nothing; (3) that these "factors" account for the "incipient stages" which are seized upon and cumulated by natural selection; that they press the button, as it were, leaving natural selection to do the rest; and (4) that species are exactly like inorganic types, and that the opinion that they are distinguished by fitness is erroneous.

If failure to discover which of these is the "Lamarckian view" is failure to understand this view, I frankly admit that I have "quite failed," although I regret this the less since all these hypotheses seem to me equally unsatisfactory. I do not know how many hold the opinion that the conception of fitness, as distinctive of species, is erroneous; but as I hope the common

sense of most will ultimately hold a fretful few in awe, I shall not dwell upon this point of view at present, except to call attention to the familiar fact that the phenomena of geographical distribution are inexplicable unless species are more or less fitted for that state of life to which they are born.

As regards the hypotheses which I have numbered 1, 2, and 3, it is clear that unless the "Lamarckian factors" can be proved competent to explain the incipient stages of useful structures, they cannot be competent to do what 1 and 2 attribute to them. I therefore asked, in my letter on Lamarck and Lyell, for evidence that the influence of the so-called Lamarckian factors is beneficial, and I asserted that I learned, from the study of Lyell's *Principles of Geology*, to ask for this evidence, and to refuse, in its absence, to admit that these "factors" explain even these incipient stages.

I had supposed that, by their "factors," Lamarckians mean use and disuse, effort, and the direct action of the conditions of life: but as I have "quite failed to understand" their views, this may be a mistake. At any rate, instead of giving evidence that the influence of these conditions is beneficial, the author of the "Reply" tells us all adaptations must be ascribed to the fundamental properties of protoplasm, although this statement, while it may be true, has no more claim to be called an explanation than the assertion that the origin of steam engines is to be ascribed to the fundamental properties of matter; an assertion which may also be quite true for all I know to the contrary.

This writer objects to my statement that I learned from Lyell that the Lamarckian factors cannot be accepted unless they can be shown to be inherently beneficial, since he is not able to learn anything of the sort from this author; although I suppose my statement will be justified if I can show that others, including Lyell himself, have made the same deduction from his teaching. His biographer in the *Encyclopædia Britannica*, after speaking of his mastery of the work of Darwin and Wallace says: "Then it was that Lyell, who had rejected Lamarck's theory because it rested on a purely imaginary law of *innate progressive development*, at once accepted natural selection."

Darwin's letters show, however, that this acceptance did not come "at once," but that Lyell had much difficulty in perceiving the fundamental difference between Darwin's views and those of Lamarck, and that he for some time thought his criticism of Lamarck applies to Darwin also. After Lyell had read the proof sheets of the *Origin of Species*, Darwin wrote to him as follows, Oct. 25, 1859, in answer to a letter which, unfortunately, is not printed in either Lyell's or Darwin's "Letters." "Our difference on 'principle of improvement' and 'power of adaptation' is too profound for discussion by letter. If I am wrong, I am quite blind to my error. If I am right, our difference will be got over only by your re-reading carefully and reflecting on my four first chapters. I supplicate you to read them again carefully."

Darwin is no doubt right, and anything further is a waste of words; for those who do not get the matter straight by reading and reflecting on these four chapters remind one of the five brethren of a certain rich man mentioned in history.

Budding in *Perophora*. By W. K. BROOKS and GEORGE LEFEVRE.

(Abstract of a paper presented to the National Academy of Sciences, April 23rd, 1896).

In the *Johns Hopkins University Circulars*, No. 119, June, 1895, the junior author of this paper published a short note on the budding of *Perophora viridis* Verrill. From a further and more exhaustive study of the subject we have since arrived at fuller and more detailed results, than those obtained at that time, and now give in brief a summary of the chief points in the budding of this Ascidian, in anticipation of the complete paper, which will appear shortly.

The material which has been at our disposal, was obtained at Beaufort, N. C. and at Woods Holl, Mass., and contained an unlimited supply of buds. The results are based on a study of an uninterrupted series of stages of both serial sections and buds mounted as total preparations.

The buds are formed in a single row on one side of the branching stolons, and always arise in the plane of the stolon double-walled partition, which divides the cavity of the stolon longitudinally into two compartments or sinuses. The latter contain the free cells of the blood, and are in open

communication at all times with the body cavities of the buds, so that a free circulation of blood is kept up from the one to the other.

The definitive median sagittal plane of the bud coincides with the plane of the stolon partition, and, therefore, the latter structure divides the stolon into a right and left half in reference to the parts of the bud.

The first appearance of a bud is announced by the thickening at a given point of the ectodermal wall of the stolon, which becomes slightly raised up into a hemispherical protuberance. The ectodermal cells, which are elsewhere flat and attenuated, are here nearly cuboidal.

By making a cross section through the stolon at such a place, it is found that the walls of the stolon partition are no longer closely pressed together, but are wide apart, and greatly thickened on the side next to the bulged-out ectoderm.

The thickened portion of the partition soon grows out into the ectodermal evagination, and becomes closed off as a vesicle by the coming together of the walls of the partition inside the stolon proper.

This evaginated, thickened part of the partition forms the "endodermal vesicle" of the bud-rudiment, and its cavity is to be regarded as being in communication for some time with the potential cavity of the partition, as the connection with the latter is not lost until a much later stage.

When the protrusion of the bud-rudiment beyond the surface of the stolon, has proceeded to a certain extent, the ectodermal connection becomes somewhat constricted, and the rudiment, which has now a spherical form, stands out on the stolon as a round knob. It does not long retain this shape, but soon begins to elongate in the direction of the free tip of the stolon. It is now ellipsoidal in form with its long axis parallel to the long axis of the stolon, and one end lies free over the surface of the stolon beyond that portion which is directly connected with the latter. It is this free end which is later to be distinguished as the anterior part of the bud, while by the process of elongation anteriorly, the connection with the stolon comes to be left behind in the posterior region. The side next to the stolon becomes the ventral surface of the bud, and that opposite it, the dorsal.

By this time the rudiments of several structures begin to appear. They do not all arise simultaneously, however, and although the pericardium is the earliest to be laid down, it will be necessary to describe the formation of the peribranchial sacs first, in order to render intelligible certain relations between these and other structures.

THE PERIBRANCHIAL CAVITY.

The observations on the development of this structure in *Perophora viridis*, although agreeing with those of Hjort¹ on *Botryllus*, in so far as they show that the peribranchial sacs do not arise separately as closed vesicles, which later unite dorsally to form the cloacal cavity, indicate that the process is not so simple as that which occurs in *Botryllus*.

If a transverse section of a young bud be examined at about the time when the elongation, spoken of above, is just beginning, it will be found that the wall of the inner vesicle is no longer of uniform thickness, but that it is much thicker on the right side than elsewhere. This is the first indication of a marked change, which now takes place in the internal relations of the bud.

By a peculiar process which may be described as a transverse or rotatory growth affecting the inner vesicle, the thickened right wall is carried or pushed down, until it comes to lie on the ventral side, that is the side next to the stolon. The connection with the stolon partition remains stationary and the rotatory shifting of the vesicle takes place on this as a fixed support. The actual right side of the vesicle at the beginning is therefore morphologically the ventral side, as it ultimately forms the floor of the pharynx, and several organs which have a definitive ventral position, make their appearance first high up on the right side.

As the displacement of the inner vesicle proceeds, the difference in thickness between what was at first nearly the whole right side, and the rest of the vesicle, becomes more marked. The cells composing the entire vesicle, except in the thicker region, which remains uniform, are seen to be growing more and more flattened. It would, therefore, seem most probable, that this shifting or displacement is brought about by the rapid growth and drawing-out of the cells which make up the greater portion of the wall of the vesicle.

Very soon after this process begins, the wall of the vesicle on the ventral side is folded in in such a way as to divide off a part of the vesicle on the left side, which is united to the stolon partition by the original connection; this is the *left peribranchial sac*. The fold begins somewhat in front of the middle of the vesicle, and deepening rapidly in this region, gradually extends posteriorly.

The first indication of the *right peribranchial sac* is a slight longitudinal folding-in of the wall of the inner vesicle, some distance up on the right side, and appears after the shifting of the vesicle has begun. As in the case of the left fold, the right one also begins near the middle of the bud, and as it deepens and extends towards the posterior end, it is carried down ventrally with the displacement of the vesicle.

As the shifting continues, the inner vesicle tends more and more to assume a symmetrical position. The two longitudinal folds, which grow rapidly and run in obliquely to meet each other, do not come together on the dorsal surface of the vesicle but some distance below it. The result of this is, that, when the right and left peribranchial sacs are separated from the inner vesicle, a median dorsal portion connecting the lateral sacs, is cut off at the same time. This median piece, the cloaca, therefore does not arise from the fusion of the lateral sacs dorsally, but the three parts are constricted off together. This is essentially the same process as that which Pizon¹ and Hjort (l. c.) have described for *Botryllus*.

In *Perophora viridis* the folds which separate the peribranchial cavity from the inner vesicle, do not involve the entire length of the latter, but leave nearly the whole of the anterior half undivided, as well as a short portion at the posterior end.

When the right and left sacs are being formed, as just described, a broad pouch or diverticulum grows out from the anterior margin of each, and gradually spreads over the undivided portion of the inner vesicle. These pouches are merely continuations or extensions of the lateral sacs, and later completely cover the sides of the anterior region of the branchial sac.

Similar prolongations are carried out from the posterior margin of the sacs, and though not prominent at first, as the bud becomes older and increases in length, they attain a considerable size.

According to Pizon (l. c.) in *Botryllus* the inner vesicle gives off two posterior lateral diverticula which are cut off together with the peribranchial cavity, and then appear as posterior prolongations of the latter, with which they always remain in communication. They are what Pizon calls the "*diverticules périviscéraux*," and from the fact that they arise as diverticula from the posterior end of the inner vesicle, he regards them as homologous with the epicardial sacs of some other Ascidians. If this relationship is true, the connection of the "epicardial sacs" in *Botryllus* with the peribranchial cavity is probably the result of the early separation of the latter from the inner vesicle.

In the light of these considerations, it is possible then, that the posterior extensions of the peribranchial sacs in *Perophora viridis* have the same significance, but it is to be borne in mind, however, that if such be the case, their direct origin from the inner vesicle has been lost completely, as they do not appear until a very late stage, and then merely as prolongations backward of the peribranchial cavity, after the latter has been entirely severed from the inner vesicle. This would therefore be a still more modified condition than that which occurs in *Botryllus*.

Pizon makes the statement that in the buds of *Perophora Listeri* he has found that epicardial tubes arise as two diverticula from the posterior end of the branchial sac, in the same manner as has been described for *Amaronium*, *Clavelina*, etc. Such an account is not in the slightest accord with our observations, and if epicardial tubes arise in this manner in the buds of the European species, they certainly do not in *Perophora viridis*.

THE BRANCHIAL SAC.

That portion of the primitive inner vesicle which is left after the separation of the peribranchial cavity, becomes the branchial sac or pharynx. The thickened right wall of the vesicle, as already stated, is shifted or pushed down until it comes to lie on the ventral side, where it forms the floor of the future pharynx.

Very soon after the vesicle has begun to change its position, a slight longitudinal groove is found on the inner surface of the vesicle high up on

¹ Mitth. Zool. Staat. Neapel, 10 Bd., 1893.

¹ Ann. Sc. Nat. Zool. (7) T. 14, 1893.

the right side. It runs through the middle of the thickened area—that is to say, above and below it there are equal portions of the thick wall, which will lie on its right and left, when by the displacement of the vesicle the groove is brought down to the mid-ventral line. By the deepening and widening of this groove, and by the differentiation of the cells bordering upon it, the definitive *endostyle* is formed.

After the appearance of the gill-slits, each of which arises as an independent formation, the pharynx is put into communication with the peribranchial cavity.

The ectoderm of the bud becomes greatly thickened at a point opposite the extreme anterior end of the branchial sac, and invaginates until it touches the wall of the latter. A complete fusion then takes place, an opening breaks through, and the branchial orifice is established.

The cloacal orifice is formed in exactly the same way, by the union of an ectodermal invagination with the wall of the cloaca at the anterior end of the latter.

THE DIGESTIVE TRACT.

Some time before the displacement of the inner vesicle is completed, and when the folds, which will cut off the peribranchial cavity, are not very deep, the wall of the inner vesicle far up on the left side at the extreme posterior end, becomes much thickened, and at once evaginates to produce a little blind pouch, the rudiment of the *digestive tract*. This lateral diverticulum grows out as a tube, which bends sharply downward and forward, while through the displacement of the vesicle its proximal end is carried up to the mid-dorsal line.

The tube very soon turns abruptly on itself to form a U, and now growing upward along the outer wall of the left peribranchial sac, until it reaches the dorsal surface, it there bends directly forward and stops short at the posterior wall of the cloaca. Here a fusion takes place, and an opening breaks through to form the anus.

The differentiation into oesophagus, stomach, and intestine is apparent at quite an early stage, and the whole tract, which lies entirely on the left side of the bud, later becomes closely enveloped by the outer wall of the peribranchial cavity.

The "pyloric gland," or "*organe réfringent*" of Giard, arises as a tubular diverticulum from the anterior wall of the stomach, and produces a dichotomously branching system of tubules which form a lace-work closely surrounding the intestine. Each tubule terminates in a little vesicle or ampulla, whose walls are made up of very flat cells containing deeply staining nuclei.

There is nothing in the structure of this organ to suggest a glandular nature, but, as Pizon (l. c.) supposes, its function is probably to absorb the products of digestion.

THE PERICARDIUM AND HEART.

In sections of very young buds it is seen that many isolated cells of a mesodermal appearance and exactly like the free amoeboid cells of the blood, are lying at numerous points against the outer surface of the endoderm and inner surface of the ectoderm.

When the difference in thickness between the right side and the rest of the inner vesicle is becoming apparent, a marked tendency in these scattered cells to accumulate in one spot, is noticed. At first there is but a single layer of cells joined loosely end to end and forming an elongated patch adhering to the outer wall of the inner vesicle high up on the right side in the posterior end of the bud. This is the rudiment of the *pericardium*, which is the first organ to make its appearance.

There is no reason for believing that these cells are not true mesodermal cells, for in the early stages of development the similarity between many of the free cells of the blood and those which make up this mass, is perfectly apparent. There is certainly not the slightest evidence that the wall of the inner vesicle evaginates or its cells proliferate at this point, the line of demarcation between the two structures being distinct and unbroken throughout.

With the displacement of the vesicle, the rudiment, which is firmly attached to the wall of the latter, is passively carried down to the ventral side, but long before it has reached its definitive position, it has become thicker and more compact, and a cavity has appeared in its centre, around which the cells arrange themselves into a one-layered epithelium to form an elongated closed sac.

When the change in position of the vesicle is completed, the pericardial sac loses its attachment to the wall, and a longitudinal folding-in of the dorsal side takes place in the usual way to form the heart.

THE DORSAL TUBE AND GANGLION.

Very soon after the cells which make up the rudiment of the pericardium, have made their appearance, a similar collection of cells is found on the outer surface of the inner vesicle somewhat to the left of the median dorsal line in the anterior end of the bud. These cells, which are at first very loosely grouped together, form an irregular, elongated mass, the rudiment of the *dorsal tube*, and so gradual is the transition from the surrounding cells of the blood to those of the rudiment, that at this early stage it is impossible to say where the former end and the latter begin.

As in the case of the pericardium, there is every reason to believe that the dorsal tube is likewise formed of true mesodermal cells. The line of separation between the rudiment and the wall of the vesicle is perfectly distinct and clearly marked, and there is no evidence whatever of proliferation of endodermal cells at any point, while during the early stages the cells which are to give rise to the tube, and the free amoeboid cells of the blood, are identical in size and appearance.

The rudiment gradually increases in size, and the cells composing it become closely packed together to form a solid, elongated mass, firmly adhering to the wall of the vesicle. A lumen appears in the centre, around which the cells arrange themselves into an epithelium, and the structure has now the form of a long tube closed at both ends.

By this time the tube has been carried up to the dorsal mid-line by the shifting of the inner vesicle, and later its anterior extremity fuses with the dorsal wall of the branchial sac, whereupon an opening breaks through to put the lumen of the tube in communication with the branchial cavity.

In the preliminary note, referred to at the beginning of this article, the statement was made that "the ganglion is formed by a thickening of the dorsal wall of the tube, which eventually becomes constricted off." More careful study of very young stages has shown that this is not a correct description of the formation of the ganglion.

About the time that the dorsal tube acquires its opening into the pharynx a few cells, identical in appearance with the mesodermal cells, are found adhering to the dorsal surface of the tube along nearly the whole length of the latter. It is a difficult question to decide whether these cells are mesodermal, as their appearance indicates, or whether they are wandering cells from the wall of the tube, for in many places the border of the latter is broken and there is a decided indication of migration of cells into the rudiment. On the other hand, it is perfectly evident, especially in later stages, that free amoeboid cells are added to the mass from without. The conclusion has therefore been drawn that the ganglion has a double origin, and that both the dorsal wall of the tube and free mesodermal cells co-operate in forming it.

The rudiment increases enormously in size, the cell-boundaries are completely lost, and the nuclei arrange themselves peripherally into two or three layers around a central core, in which fine fibrils are afterwards laid down. The definitive structure of the ganglion is then attained.

THE SEXUAL ORGANS.

Our observations on the development of these organs closely agree with the description given by Van Beneden and Julin¹ for the buds of *Perophora listeri*.

Shortly after the peribranchial cavity has been completely separated from the branchial sac, a small collection of mesodermal cells is found lying in front of the wall of the stomach almost at the point where the latter is connected with the duct of the "*organe réfringent*." A cavity soon appears in the centre of the mass, which now assumes a spherical shape, and becomes connected with a solid string of mesodermal cells, the genital cord, running parallel to the intestine and extending all the way to the posterior wall of the cloaca.

As the Belgian authors have shown, from this simple sphere and single cord of cells, testis, ovary, vas deferens, and oviduct are all differentiated later.

¹ Arch. de Biologie, T. 6, 1887.

Notes on the Chaetognaths. By F. S. CONANT.

The following notes are based in part upon observations made at Beaufort, N. C., during the summer of 1895, and in part upon later work on preserved material. That which concerns the egg-laying rests wholly on one form, *Sagitta hispida*, a species very much like the *Sagitta bipunctata* of European writers, which was described by me in the *University Circular* for June, 1895 (No. 119). With the exception of *Sagitta hispida* and another form, *Spadella schizoptera*, described in the same article, the Chaetognaths of American waters have not been subjected to the European standards of classification, and in the systematic part of this paper an attempt has been made to describe, as accurately as alcoholic material would allow, such of the American Chaetognaths as have come into the writer's hands.

1. EGG-LAYING.

So far as is revealed by a search of the literature, the passage of the ova into the oviducts has not been actually observed heretofore. The structure of the ovaries is such that no direct course is offered to the exterior, and it has been a matter of some speculation with the authors how the eggs do get into the ducts. The ovaries are two bilateral cylindrical bodies situated in the posterior part of the body segment. Along the outer edge of each there extends a duct, which opens to the exterior laterally at the level of the posterior end of the ovary. This is called by Hertwig¹ the oviduct. By Grassi,² since it is very often found to contain spermatozoa, it is called the "ovi-sperm duct." A glance at Fig. 1, which represents a cross section through the body of *Sagitta hispida* in the region of the ovaries, will show that the ova are separated from this duct by a layer of cells of the germinal epithelium. This extends between the ova and the duct throughout, and leaves no clearly marked communication, through which the eggs might pass, at either the anterior or the posterior end of the ovary. Hertwig supposes that the eggs pass into the duct near its opening posteriorly, being probably pressed through the intervening germinal epithelium. He concludes: "Ist meine Deutung richtig, so würde nur das hintere Ende des Oviducts zur Ausführung der Eier dienen, und gleichzeitig den Ort abgeben, wo die Befruchtung erfolgt, dagegen würde der grössere blind geschlossene Theil des Oviducts als eine Art Samentasche functioniren, wie der oft in ihr vorgefundene Inhalt lebender Spermatozoen beweist."

Grassi finds that the wall of the ovi-sperm duct is interrupted at irregular intervals, and that through these interspaces spermatozoa may pass into the ovary before the ova are mature, sometimes penetrating the unripe ova and causing degenerative changes. These interruptions in the wall exist along the whole length of the duct, and Grassi thinks that probably the ova make their way through them into the duct, thus passing into the duct anywhere throughout its length.

I may say in brief, that while my preparations show nothing of these interruptions in the wall of the duct, the actual course of events points to the correctness of Grassi's supposition, that the ova pass through some such interspaces. They do not, however, appear to pass into the "ovi-sperm duct," but into another entirely new channel. The "ovi-sperm duct" seems to function, at least throughout all but the posterior part of its course, as a receptaculum seminis, and Hertwig's supposition is found true in this regard.

Sagitta hispida, which is found in abundance at Beaufort, offers a favorable opportunity for the study of the passage of the ova into the oviduct in the living object. With this species the egg-laying occurs at about sunrise, as is stated also by Grassi for the Mediterranean form *Sagitta hezaptera*. Boveri quotes Fol as finding the eggs of *Sagitta bipunctata* laid at sunset, and he found the same himself in March, but the process was often much delayed, so that at times he waited till eleven or twelve o'clock in vain. The exact time with *S. hispida* is found to depend somewhat upon the temperature. While the eggs were generally laid about five o'clock in July and August, on a cooler morning than usual the process might be found to occur an hour later; and by artificial cooling in an ice-chest over night the laying might be delayed as much as three hours. Such artificially retarded eggs developed regularly on the whole, but it was found safer to make the observations at the earlier, normal hour.

To follow the process, then, the eggs are found in the ovary the first thing in the morning—at five o'clock in the case that we will select—with the large germinal vesicle still showing, but lying eccentrically toward the mid-line of the animal. By 5.16 the germinal vesicles have entirely disappeared. At 5.22 each egg has flattened somewhat from before backward, and a small cell is seen clearly at the outer end opposite the point where the germinal vesicle was. The ova of the Chaetognaths arise from the germinal epithelium on stalks (see Grassi, Taf. II, Figs. 9 and 10), and the small cell standing out plainly in the living object at this stage is found in sections to be the stalk cell, which thus precedes the ovum in its passage into the duct. The ovum itself now changes its spherical shape by sending out a projection, bearing the stalk cell, into the duct. Then by a progressive series of changes in shape, such as is represented in Fig. 2, each ovum makes its way into the oviduct. It is evidently passing through some such interspace in the wall of the oviduct, as was supposed by Grassi. The process occupies about eight or ten minutes. All the ova of one side pass through the successive stages of constriction at essentially the same time, the anterior being slightly in advance of the posterior. There may be a difference of time, however, between the ova of the two sides.

The eggs remain in the oviduct from twenty minutes to half an hour before being laid, during which time the layer of gelatinous substance that surrounds each is thickened. The chief change, however, is a gradual compression of the eggs from before backward, so that they become ellipsoidal. The process is aided by contractions of the ovary, especially observed at the anterior end, and as a result the eggs are pushed backward toward the external opening. When the pressure has become great enough to overcome the resistance, which seems to be offered, largely by a kind of mucous plug in the orifice, the eggs are extruded as two linear rows, one from each oviduct, the whole comprising anywhere from a few to sixty or seventy eggs.

The act of laying was seen by Boveri¹ in *S. bipunctata*. After describing the way in which the eggs were extruded, simultaneously from both sides and very quickly, with active movements of the animal, he adds: "Wobei dieselben um die enge Austrittsöffnung zu passiren aus ihrer kugelligen Form in eine gestreckte Wurstform übergingen, die im Wasser allmählich zur Kugelgestalt zurückkehrte." This description applies perfectly to *S. hispida*, the "Wurstform," however, being first produced by the crowding of the eggs in the duct, and afterwards increased by the passage through the narrow orifice. The orifice is at right angles to the main axis of the duct, so that the crowding has the result of presenting the eggs with their longest diameter in the direction of the orifice.

It has already been mentioned that the so-called ovi-sperm duct, into which the eggs apparently pass, is found to contain spermatozoa, and the inference would be that the eggs pass into the mass of spermatozoa and are there fertilized. I found last summer that soon after the eggs begin the process of constriction the previously active movements of the spermatozoa cease; that after the complete passage into the oviduct, the spermatozoa are held, as it were, congealed in a longitudinal streak external to the eggs; that when the eggs are laid there is no noticeable diminution in the number of spermatozoa, and that their active movements are later resumed. This suggested that the passage was not into the "ovi-sperm duct," and sections of material preserved at these stages confirmed the supposition. Fig. 3 shows that the spermatozoa are kept in the "ovi-sperm duct" (RS.) apart from the ova, and that the latter have made their entrance into a new and apparently temporary channel between the germinal epithelium and the epithelium of the "ovi-sperm duct." The latter is, therefore, only a receptaculum seminis, as Hertwig supposed. It may be objected that the spermatozoa are, as it were, sealed up by a secretion of mucus about them, and that this, in the hardened material, gives the appearance of a membrane; but the occurrence of nuclei seems to show that the structure is a definite one. The walls of the oviduct did not show any such nuclei, and the existence of an epithelial lining in it is doubtful.

Of course the foregoing applies only to *S. hispida*, and cannot be at once assumed to be the case in all Chaetognaths. It is probably the case, however, for *S. hispida* is a very typical form. *Spadella schizoptera* offers some collateral evidence (*Circular*, No. 119, June, 1895). In this form it was found that the two "ovi-sperm ducts" were united by a transverse branch,

¹ Die Chaetognathen: Jenaische Zeitschr., Bd. 14; 1880.

² Fauna und Flora d. Golfes von Neapel, No. 5; 1883.

¹ Zellen-Studien, Heft 3, 1890, p. 18.

a structure that would seem to have no significance in an oviduct, but would be extremely useful in uniting two receptacula seminis, inasmuch as a single copulation, affecting only one side, would thereby serve to fertilize the ova of both sides.

It would seem, then, that the female reproductive system of *S. hispida* (and perhaps all Chaetognaths) consists, on each side, of the ovary, the receptaculum seminis, and a temporary oviduct lying parallel and internal to the receptaculum and uniting with it posteriorly to open on a common genital papilla. A more detailed account of the histology of these structures could be given were it not that the Chaetognaths offer such very unfavorable material for the study of microscopic anatomy. Kleinenberg's picro-sulphuric, Perenyi's, and corrosive acetic give the best results, but even with them the objects are very unsatisfactory, and especially so during the processes of egg-laying, when the tissues are evidently being subjected to great stress.

The exact point at which the spermatozoa come in contact with the eggs I have not been able to determine. Grassi says that spermatozoa can pass into the ovary, where he has found them; but he does not state that fertilization occurs here normally. In agreement with Hertwig, I have never found spermatozoa in the ovary. Neither do the eggs appear to be fertilized in the oviduct. Before they pass out of the ovary a number of very small chromosomes (the exact number was not determined) are found toward the inner end of the ovum, or the place where the germinal vesicle disappears. During the twenty to thirty minutes that the eggs are in the oviduct before being laid, there are no changes in these bodies, and they continue to be the only chromatin that I am able to find in the egg until after the laying. The probability is, therefore, that the spermatozoa come in contact with the eggs, shortly before or during the process of laying, in the duct to the exterior common to the oviduct and receptaculum seminis.

Self-fertilization seems to be impossible, although the male and female elements develop at the same time. In the case of a *S. hispida* isolated when the ovaries contained only immature ova, I found that by the second morning 30 or 40 eggs had matured and been laid; on the third, 24 more; on the fifth, 68; on the seventh, 55-58. Of these the only ones that developed were fourteen out of the first lot, evidently fertilized by spermatozoa remaining in the receptaculum seminis. In all the others development proceeded only so far as the formation of the polar bodies. In this case the extrusion of the polar bodies is evidently not dependent upon the entrance of the spermatozoa, which Boveri states is necessary in the ova of *S. bipunctata* observed by him.

The eggs when laid become attached to the sides of the dish by a gelatinous or mucilaginous substance, which facilitates handling somewhat, but also collects dirt. The development of the young sagittae up to hatching is completed in about thirty-six hours in warm weather. When hatched they have practically the adult structure, and in four or five days they are found to eat each other with as much zeal as is shown by their elders in the same performance. It is interesting to watch a sagitta, with a relatively narrow digestive tract two-thirds the length of its body, forcing down its oesophagus a fellow of equal size, and hence one-third longer than the tract. The eating one another seems to be done purely out of natural depravity, for it occurs when plenty of the usual food, small tow-stuff, is present.

Upon the development of the eggs I have nothing to add. Like the previous observers, I have been unable to find a satisfactory method of preservation, in spite of many trials.

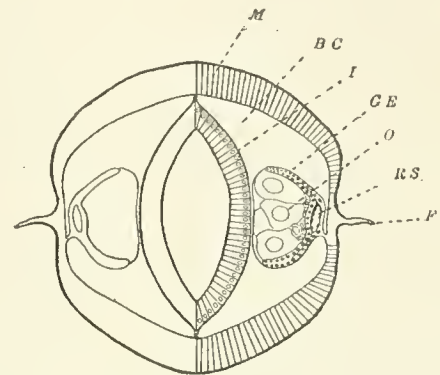
2. THE DIVERTICULA OF THE INTESTINE.

In two of the European species, *Sagitta minima* and *Spadella cephaloptera*, a pair of diverticula are described as occurring at the anterior part of the intestine. In the American forms this structure is more common, being found in three of the nine species about to be enumerated. In *S. hispida* they appear from the surface as outlined in Fig. 4. A cross section through the animal in this region would show the digestive tract composed of three tubes lying side by side, as figured by Grassi for *Spadella cephaloptera* (Taf. 6, Fig. 11), of which the middle one is in reality only the oesophagus, as it enters the stomach intestine. The epithelium of the diverticula is the same as that of the intestine, and they seem to be in fact only the prolongations of the intestine anteriorly beyond the point where the laterally compressed oesophagus makes connections with it. In a variety of *S. hispida* from the Bahamas the diverticula are reduced to a very small size, and

cannot have much function. In the Beaufort *hispida* and in *S. elegans* they may vary according to the individual—in some large, in some small.

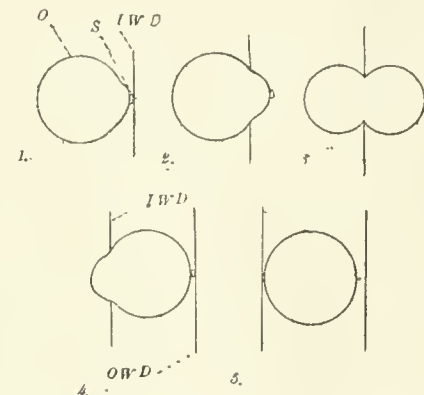
An interesting modification of apparently the same structure occurs in *S. elegans*. In many of the specimens from Woods Holl, diverticula are found

Fig. 1.



extending within the digestive tract. Fig. 5 gives a diagrammatic representation of these structures. A cross section in this case would show a

Fig. 2.



large tube, the oesophagus, enclosing two smaller, yet relatively large tubes, the diverticula. The latter bear on the surface that is turned toward the digestive tract an epithelium like that of the rest of the tract, and they thus

Fig. 3.

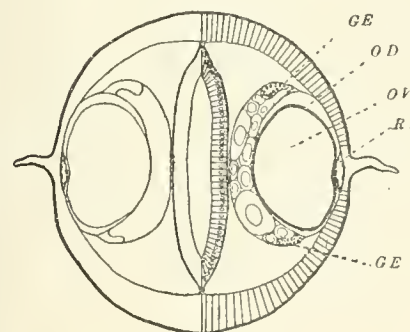
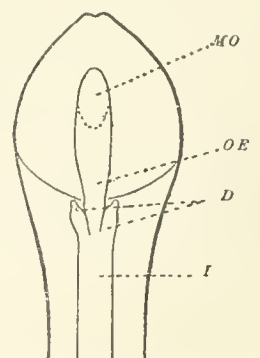


Fig. 4.



represent exactly the structure that might be produced by pushing external diverticula back upon themselves into the digestive tract. Much careful examination failed to reveal any specific differences between the animals having external and those having internal diverticula. It may be that

observation of living specimens, however, would show that we have here two species. There is a possibility also that the two forms are different phases of the same structure in one and the same animal, but this seems to me improbable. Some specimens having internal diverticula show a formation at the base of these suggestive of external diverticula as well.

The function of such internal diverticula can hardly be surmised. The lumen, which is connected with the body cavity, is often found to contain coagulated coelomic fluid. What strikes one most prominently, however, is that they would seem of necessity to be very much in the way in the act of swallowing.

3. CLASSIFICATION.

In May, 1895, E. Béraneck published in the *Revue Suisse* (Tome III, Fasc. 1), an article entitled "Les Chétognaths de la Baie d'Amboine," in which he devoted several pages to a critical review of the systems of classification. After comparing the defects in the classifications of Langerhans (followed by Strodttmann¹ in 1892), Hertwig and Grassi, he came to the conclusion that the first offers the most advantages in our present state of knowledge.

At about the same time (*Univ. Circular*, June, 1895) I was having difficulty in finding a place for *Spadella schizoptera* in any of the systems. It seemed to me that Grassi's classification met the case the most satisfactorily, except that he unfortunately interchanged the names of his two genera, so that his *Spadella* very nearly represented the *Sagitta* of other authors.

Now, however, having seen Béraneck's paper, and having studied more forms, I am inclined to admit the full weight of the arguments against Grassi's system. Dividing a group of animals into two genera, one characterized by certain features and the other by the absence of those features, is of itself enough to condemn the system. But at the same time it seems to me that Grassi's objections to the system of Langerhans, as based upon structures of such slight morphological importance as the fins and teeth, are equally sound. Yet the classification of Langerhans is very convenient, and on this account, and because it has been adopted by the last writers on the Chaetognaths, I have followed it, except in one case—in the systematic portion that is appended. But that it, as well as the others, is unsatisfactory, can be readily shown by instances from the American species, in addition to the cases given by Béraneck.

For example, *Spadella schizoptera*, according to Langerhans and Hertwig, would be called a *Sagitta* on account of its five fins; only Grassi's system would retain it with the closely related *Spadella cephaloptera*.

Spadella maxima in the classification of Langerhans would belong to the genus *Krohnia*, or to the genus *Spadella*, according as the fins or the teeth were accounted the more important; for its one pair of lateral fins lies partly on the trunk, partly on the caudal segment (*Krohnia*), while the teeth are in two series (*Spadella*). According to Grassi it would probably be placed in his genus *Spadella* (*Sagitta* of the others), for none of his characteristics for the genus *Sagitta* (*Spadella* of the others), was found in the specimens studied. And yet in its coloration and in its habitat near the bottom, it is evidently allied, notwithstanding its size, to the small *Spadellae*.

By Langerhans *Krohnia hamata* is set apart with one other species to form a genus by themselves, characterized only by the fact that in connection with one pair of lateral fins there is but one series of teeth. According to Hertwig it is included with the *Spadellae*, notwithstanding its free-swimming life at the surface. According to Grassi it would probably be included with the *Sagittae* (his *Spadellae*), although the form studied by me showed the transverse musculature that is a characteristic of the *Spadellae* (his *Sagittae*).

These cases are additional proof that none of the divisions of the Chaetognaths into genera is satisfactory, while for convenience sake and from deference to the later writers, I have followed the classification of Langerhans, it would perhaps have been as well to give up the distinctions *Spadella* and *Krohnia* altogether, and retain only the one genus *Sagitta*.

4. SYSTEMATIC.

The Known Chaetognaths of American Waters.

1. SAGITTA ELEGANS (Verrill).

Strodttmann mentions this species (loc. cit.), but was unable to find a description of it in the literature at his command. Professor Verrill's account is found on page 332 [626] of the "Report upon the Invertebrate

Animals of Vineyard Sound and Adjacent Waters." (Washington: Government Printing Office, 1874).

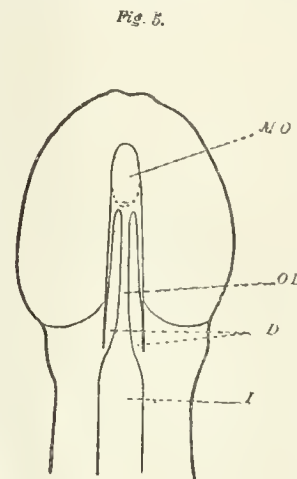
S. elegans resembles the widespread *S. bipunctata*. The length of the largest specimens in my possession is 25–30 mm. Maximum breadth, 1 mm. Caudal segment, one-fifth total length. Fins 5, like those of *bipunctata* or *hispidia*. Seizing-hooks, 9–12, shaped as in *bipunctata*. Anterior teeth, 5–7. Posterior teeth, 12–15. Corona ciliata, elongated sinuous oval, as in *bipunctata* or *hispidia*. Diverticula of intestine both external and internal, as described in the preceding. Accessory longitudinal septa present in caudal segment. Tactile prominences generally few as compared with *S. hispidia* (see Fig. VII in *Circular* for June, 1895). Musculature of body not so stoutly developed as in *hispidia*. Head well marked off from trunk. Epidermis thickened around the neck.

S. elegans differs from *bipunctata* in size, in the relative proportions of caudal and body segments and in the presence of diverticula from the intestine. It is found at Wood's Holl, Mass, in winter, sometimes in great abundance. In summer it is rare there. None of the many specimens that

I have seen, taken in the winter months by Mr. Vinal Edwards of the Fish Commission, contained mature ova.

The name *elegans* was applied by Professor Verrill to specimens 16 mm. long; he also mentions a "much larger and stouter species than the preceding, taken in abundance in Vineyard Sound from January to May, 25–30 mm. long." I have not been able to find any specific difference between the large and small specimens from Wood's Holl, and do not doubt that they are the same.

Strodttmann mentions a "*S. gracilis*," figured by Verrill in the "Results of the Explorations made by the Steamer Albatross off the Northern Coast of the United States in 1883." Professor Verrill has very kindly replied to my inquiry in reference to this, that the figure is of *S. elegans*, the name "*gracilis*" being the result of a clerical error. The large salmon or orange-colored form mentioned in the same article is the species next described.



2. SPADELLA MAXIMA (Sp. nova).

Specimens of this and the two following species were given me by Professor Verrill from the Albatross material in his possession, and I am indebted also to Dr. G. Brown Goode, of the National Museum, for permission to include them in this list.

Spadella maxima is an unusually large and stout Chaetognath, 52 mm. long and 5 mm. wide. Its one pair of lateral fins extends along the posterior two-thirds of the body segment and the anterior third of the caudal segment. According to the classification followed by Strodttmann, therefore, it would belong to the genus *Krohnia*. The reasons for including it among the *Spadellae*, which otherwise are without exception small animals, are found in the note on classification. Seizing-hooks, 6. Anterior teeth, 3–5. Posterior teeth, 5–7. The corona could not be made out satisfactorily in the preserved specimens; it seemed to resemble the pear-shaped form found in *S. hexaptera*. No diverticula from intestine. Muscles slender in proportion to the breadth of the body, a large lateral area on each side between the dorsal and ventral bands being free from muscle. Epidermis thickened to several layers of cell around the neck.

The specimens had been in alcohol for some years, and were entirely devoid of the "deep salmon or orange-color" mentioned by Professor Verrill as characterizing them from the colorless surface forms. They were brought up in the trawl wings at Station 2428 of the Albatross, in the North Atlantic, lat. N. 42° 48', long. W. 50° 55' 30''.

3. KROHNIA HAMATA (Möbius).

Chaetognaths evidently belonging to this species were taken in the trawl-wings at Station 2045, off Martha's Vineyard. They have one pair of very delicate lateral fins, hooks bent sharply at the tips, anterior teeth wanting, and a very large number of posterior teeth—all of which are characteristic

¹ Archiv. für Nat. gesch., 58; 1892.

of *K. hamata*. But they offer one unusual variation in the possession of a well-marked ventral sheet of transverse muscle, such as in Grassi's classification is characteristic of his genus *Sagitta* (*Spadella* of the others). It extends from the beginning of the neck as far back as the posterior edge of the abdominal ganglion.

4. SAGITTA HEXAPTERA (D'Orbigny).

From the same station as the preceding there are some specimens 24-34 mm. in length, which do not differ enough from the *S. hexaptera* of European writers to warrant establishing a separate species. The caudal segment is one-fourth to one-fifth the total length. Fins, 5. Seizing-hooks, 7-8. Anterior teeth, 3-4. Posterior teeth, 4-7. Ovaries immature. The body muscles are stouter than is stated for *hexaptera*, however, and the specimen sectioned showed two large external diverticula from the intestine. It is very possible that study of fresh material would show them to be a distinct species, instead of young *hexaptera*.

5. SAGITTA FLACCIDA (Sp. nova).

This species was collected by Dr. Andrews at Bimini, in the Bahamas. Length, 13-18 mm. Breadth, 1.25 mm. Caudal segment about one-sixth total length. Fins, 5—the middle and anterior comparatively short. Seizing hooks, 8 or 9. Anterior teeth, 7 or 8, the inner very much longer than the outer. Posterior teeth, 10-12. Corona ciliata almost wholly confined to the head, of an irregular oval outline. Ovaries, containing well advanced ova, short. No diverticula from digestive tract. Caudal segment not divided longitudinally by incomplete, accessory septa, but showing an arrangement of the testes and developing spermatozoa like that figured by Grassi for *S. hexaptera* (Taf. 9, Fig. 7). Muscles of body slenderly developed, causing the preserved specimens to have a very limp appearance. Epidermis but slightly thickened around the neck, if any at all.

Of the European forms, *S. flaccida* resembles *hexaptera* and *magna* the most closely. It differs from them, however, in being much smaller, in having a larger number of teeth, in the smaller size of the caudal segment, and in the shape of the corona.

6. SAGITTA TENUIS (Sp. nova).

S. tenuis is a small species from Jamaica, very closely resembling *S. hispida*. I am indebted to Mr. C. P. Sigerfoos for the specimens, which were collected by him in Kingston harbor, June, 1893. Maximum length, 5.25 mm. Breadth, 0.2 mm. Caudal segment, about one-fourth total length. Seizing-hooks, 7-8. Anterior teeth, 4-5. Posterior teeth, 7-10. Shape of fins, of seizing-hooks, corona ciliata, accessory longitudinal septa in caudal segment, number of tactile prominences, and muscularity of body—as in *hispida*. No diverticula from digestive tract. In this form the nervous structures are especially large and prominent. The ovaries were short, though containing ova approaching maturity. Germinal epithelium composed of a single row of high columnar cells, not a double row of cubical, as in the forms like *bipunctata*.

S. tenuis differs from *hispida* in size, in the prominence of the nervous structures, in the relatively shorter caudal segment, and the absence of diverticula from the digestive tract. It might seem that the specimens were young *hispida*, were it not for the advanced ova and for the fact that diverticula were not present, while in *hispida* they are very apparent as early as twenty-four hours after hatching.

7. SPADELLA DRACO.

Among the *S. flaccida* collected by Dr. Andrews at Bimini was a single specimen of this species. The cosmopolitan nature of certain of the Chaetognaths is well illustrated by it. In his article on "Les Chétognathes de la Baie d'Amboine" (Malay Archipelago), E. Béraneck says: "La Spadella draco est la plus commune des espèces de ce genre trouvées dans la pêche pélagique de la baie d'Amboine."

8. SPADELLA SCHIZOPTERA.

This very unusual species was described in the *Circular* for June, 1895. It is another of the forms from the Bahamas.

9. SAGITTA HISPIDA.

This form was described at the same time as the preceding. We have found it in Jamaica, at Beaufort, North Carolina, and at Bimini, in the

Bahamas. Mr. A. Agassiz has found it elsewhere in the Bahamas, in the cruise of the "Wild Duck" in 1893.

EXPLANATION OF FIGURES.

FIG. 1.—Cross section of *Sagitta hispida* with eggs still in the ovary. M, muscle; BC, body cavity; I, intestine; GE, germinal epithelium; O, ovarian eggs; RS, receptaculum seminis; F, lateral fin.

FIG. 2.—Diagrams illustrating the successive stages of constriction in the passage of an egg into the oviduct. O, ovum; S, stalk cell; IWD, inner wall of the oviduct; OWD, outer wall.

FIG. 3.—Cross section of *Sagitta hispida* with eggs in the oviduct, before laying. GE, germinal epithelium; OD, oviduct; OV, ovum; RS, receptaculum seminis.

FIG. 4.—Diagrammatic optical section of the head and neck of *S. hispida* from above. MO, mouth; OE, oesophagus; D, diverticula; I, intestine.

FIG. 5.—The same as Fig. 4, for *S. elegans*.

Notes on the Anatomy of Yoldia, I. By W. K. BROOKS and GILMAN DREW.

[Abstract of part of a paper reported to the National Academy of Sciences, April 23, 1896.]

In the year 1874 one of the authors published a short paper in the Proceedings of the American Association for the Advancement of Science calling attention to an organ of special sense in the Lamellibranch *Yoldia*. This organ consists of an unpaired tentacle which arises from the mantle near the base of the siphons, and is apparently tactile in function.

Since the appearance of this paper many writers on Lamellibranch anatomy have mentioned this organ of special sense, but very little has been added to our knowledge of it. Pelseneer has noted it as occurring on the right side of such specimens of *Leda* as he has examined;¹ on the left side of his single specimen of *Malletia pallida*; and on either the right or left side, but never paired, in *Yoldia isonota*.²

This paper will deal briefly with the position, structure, and nervous connection of this organ in *Yoldia*.

Two species have been studied, *Y. limatula* and *Y. sapotillo*. Most of the material was obtained through Mr. Richard Rathbun, of the U. S. Fish Commission, and Dr. James L. Kellogg, of Olivet College.

The siphons, long and slender in the adult animal, arise as ridges at the mantle margin, which ultimately unite in such a manner that two closed tubes are formed. A muscle is developed which serves to retract the siphons, and thus they may be completely withdrawn between the mantle lobes, although their bases originate at the mantle margins.

The tentacle under discussion is attached to the point of union of the ventral siphon with the adjacent mantle lobe, on a level with the ventral border of this siphon, and it lies, when the siphons are retracted, between the mantle lobe to which it is attached on one side and the walls of the siphons on the other. In both of the species examined the tentacle occurs in about equal proportions on the right and on the left sides, but is apparently never paired. When extended, it is a long and slender filament, gradually tapering to its free extremity, and set throughout its length with small, somewhat conical papillae, at the tip of each of which ample magnification shows a cluster of sense hairs. When retracted it presents a series of transverse wrinkles which tend to obscure these sense papillae. Beneath the surface layer of epithelium run strands of longitudinal muscle fibres imbedded in connective tissue. On the side nearest the mantle lobe to which it is attached (right or left, according to its position), and beneath the muscle layer, is a large nerve which can easily be traced to the tentacle's tip. On the side opposite the nerve, also within the muscle layer, is a more or less definite space in the connective tissue which is likewise continuous the length of the tentacle. This space, which appears to be a blood space, is best seen in cross sections of a somewhat extended tentacle, in which case remnants of a coagulum may be seen in it. Extension of the tentacle seems to be accomplished solely by forcing blood into this space. When the muscles of the tentacle contract, the blood is forced back, and the space may be completely obliterated.

From the posterior end of each visceral ganglion a nerve arises which soon divides. One of these divisions is distributed to the siphons and their retractors, the other to the posterior portion of the mantle margin. It is

¹ Contribution à l'étude des Lamellibranches, Tome XI, Archives de Biologie.

² Report on the anatomy of Deep Sea Mollusca, Zool. Challenger Exped., pt. LXXIV.

from this latter division that the tentacle receives its nerve. In specimens in which the siphons are strongly retracted, the base of the nerve which supplies the specialized tentacle is pulled some distance above the tentacle's base. The two nerves which now lie side by side near the base of the tentacle form a mass of nervous matter which appears, superficially, much like a ganglion, and doubtless has been mistaken for one.

The posterior ventral margins of the mantle are fringed with ordinary marginal tentacles which have, beneath the superficial layer of epithelial cells, both longitudinal and transverse strands of muscle fibres and generally several blood spaces. Although I have been unable to trace branches of the pallial nerves into these tentacles, I have traced them to their bases, and there can be little doubt that they are supplied by fibres from these nerves.

If, then, we consider the following points: 1st. The specialized tentacle is marginal in formation, and is carried back with the siphons during their development, and more especially by their retraction; 2nd. It is placed sometimes on the right and sometimes on the left side, which may indicate that it is an organ of late specialization, not thoroughly settled in position; and, 3rd. It receives its nervous supply as a branch of the same nerve which supplies the marginal tentacles: It may be justifiable to call attention to a possible homology, between the specialized tentacle and a marginal tentacle which has become slightly modified in structure and very much enlarged and specialized.

The Development of a Termite—*Eutermes* (Rippertii?) A Preliminary Abstract. By H. McE. KNOWER.

During my tenure of the Adam T. Bruce Fellowship this past winter I have studied the development of a species of Termite closely related to *Eutermes Rippertii*, Rambur. The material was collected in Jamaica, and the work was undertaken as part of a more extended investigation of the biology of the Termites, and because of the primitive character of the group, the embryology of which has not been hitherto studied.

In its general features the embryology is quite similar to that described by Brandt for the Libellulid, *Calopteryx*;¹ but on the whole I should say it resembles rather more the development of certain of the Orthoptera. Like *Stenobothrus*, *Oecanthus*, &c., the first rudiment of the embryo, is a small disc near one pole of the egg. In the Termite this disc is on the ventral surface, just beneath the micropyles, near the posterior pole of the egg. I have studied the segmentation and early stages of the formation of the disc to find out how this rudiment arises. As a result, it is clear to me that the germ-disc is not formed immediately during the segmentation, by cells wandering from the interior of the egg directly to their places in the embryonic area. On the contrary the cells resulting from segmentation become about equally distributed to all parts of the egg. At an early stage most of the cells have reached the surface of the yolk, only very few remaining behind, as vitellophages. After attaining the surface, the cells of the blastoderm (it may perhaps be spoken of by this term, though protoplasmic continuity between its cells cannot be shown) continue to divide at all points, though the nuclei in the posterior end divide more rapidly. For a number of stages this becomes more noticeable, but it is also evident that the actively dividing nuclei are not confined to the restricted area on the ventral surface to be occupied by the disc. The nuclei of the dorsal surface near the posterior pole are as numerous and as near together, at this time, as those on the ventral surface. From this stage, to one exhibiting a sharply outlined germ-disc about to be covered by an amnion, there is apparently a concentration of the cells on the surface toward the ventral side of the egg to a point just beneath the micropyles. This, as has been said, is the place where the primary rudiment of the embryo is finally situated. Hence the embryonic disc is seen to be due, not simply to an active multiplication of the cells of a restricted area of the blastoderm, but likewise to a concentration of the blastoderm cells. This, it will be remembered, is what McMurrich has recently shown to be true in the development of Isopods.⁵ A similar concentration has been observed in the establishment of the first rudiment of other insect embryos; but in the Termite it is especially marked, owing to the comparatively small size of the germ-disc (see Patten for the Phryganids,⁶ and Wheeler for *Doryphora*⁸). Sections of the disc, during this concentration, show that cells are crowded beneath the surface from a very early stage in its formation. This takes place at all points in

the area of the disc; and the surface nuclei also divide tangentially, here and there, to separate cells which adhere to the lower surface. This is the beginning of the formation of the "under layer."

Surface views of older embryos show two changes in the disc. Near the centre a dark spot appears, and in the same stage the posterior margin becomes marked out as a semicircle of especially closely crowded nuclei. Sections of such discs show that the "under-layer" cells have become more numerous, and have collected into a plug projecting into the yolk, and making the dark spot seen on the surface. The posterior semi-circle of crowded nuclei represents the first rudiment of the amnio-serosal fold. It is, at this period, merely a more thickened margin of the disc. The area between the central plug and the amnion thickening (if it may be so spoken of) is quite thin, being a single layer of cells. These stages, as well as later ones, agree in showing no gastrula invagination; the "under-layer" being formed, as described, rather by a process of delamination, or in wandering due to crowding, and the plug being a later, secondary formation.

The facts of the origin of the "under-layer" support Heymon's¹⁰ recent views as to the formation of this layer in the Orthoptera, in as far as they indicate that invaginate gastrulas may be secondary phenomena among insects.

As to the origin of the amnion. In the Termite it is apparently, as has been said, a thickening of the posterior edge of the disc, before any trace of a fold can be distinguished in section. When this thickening folds over the disc, the amnion is seen to differ in no essential from the rest of the embryonic disc (of course leaving the "under-layer" plug out of consideration).

The enclosure of the germ-disc takes place by the single posterior semicircular fold growing forward to its anterior extremity. Just after the amniotic cavity is closed in this way, the amnion is still found to be quite thick and like the upper layers of the disc (see Bruce's Figure XLIII of *Mantis* at this stage²). A like similarity has been observed in many insects between the ectoderm of the embryo and the amnion.

The further growth of the embryo is much like that figured by Graber for *Stenobothrus*.³ While the anterior end of the disc remains fixed, the tail end grows back over the posterior pole. In this way an embryonic band is formed, which makes a cap over this pole. Both ends of the band are, at first, of the same shape. Soon, however, the anterior extremity spreads out into a broad cephalic area, which has reached its greatest extent by the time the posterior end of the band has pushed up about one-third of the dorsal surface of the egg. Segmentation now sets in—the antennary (post oral), mandibular, first and second maxillary, and first thoracic segments appearing almost simultaneously.

There are no macrosomites, as in *Stenobothrus* (Graber). The remaining thoracic and abdominal segments are added successively from before backward, as the band grows still further toward the anterior end of the egg. The labrum appears as a median unpaired fold over the mouth.

Sections of these early stages of the elongating embryonic band show that the "under-layer" does not extend anteriorly beneath the ectoderm which has spread out anteriorly over the yolk to form the cephalic lobes. Posteriorly, however, the "under-layer" follows the growth of the ectoderm, which is somewhat more rapid. A sagittal section of a band before segmentation shows the "under-layer" as a single row of cells beneath the anterior portions of the ectoderm, where its cells are sharply marked off from the ectoderm. Beneath the tail end of such an embryo the "under-layer" cells are collected into a large mass which is not sharply separated from the ectoderm. Most of the extension of the "lower-layer" is apparently due to the multiplication of its own cells. I have not yet studied the differentiation of this layer, but can state that the endoderm appears after the establishment of segments, and is not formed from vitellophages.

The sections just referred to show well the changes of the amnion until it has become a thin lamella. This is brought about as a result of the anterior and posterior extension of the embryo. The cells of the amnion are pulled out into a single row anteriorly, while posteriorly, for some time, the membrane retains something of its early appearance. When the tail end of the germ-band has reached the anterior pole of the egg in its elongation, the abdominal region sinks gradually into the yolk and the posterior extremity coils over ventrally toward the head, giving the embryo an S shape. The appendages have meanwhile grown to nearly their definitive length. The first and second maxillae are trilobed, and ten rather prominent rudimentary abdominal appendages have appeared. The cephalic region has changed considerably. Just after the appearance of the appendages the

lateral margins of the cephalic lobes began to roll up toward the mid-dorsal line. As this process continued a little pocket was formed on either side of the head, which grew gradually larger as the folds of the cephalic lobes approached the median dorsal line. Finally the two lateral pouches fused to form the head-cavity. The antennae were included in this folding, and hence now enclose a portion of the head cavity.

When the embryo has reached the stage just described, it resembles Brandt's figure (11) of *Calopteryx*,¹ but it is not "immersed" in the yolk. It is impossible to say just how long this "inverted" position is maintained. There is perhaps a rather short interval before "revolution," which is accomplished as described by Brandt for the Libellulid (that is, judging from preserved specimens). When "revolution" is over, the embryo lies with its head at the anterior pole of the egg, while the tail end lies beneath the micropyles, at the posterior pole. The ventral surface of the embryo, as in early stages, lies on the micropylar side of the egg.

I have not studied the development beyond the appearance of appendages, in detail, as yet; but may state that the central nervous system arises from neuroblast cells, as described by Viallanes,⁷ and Wheeler,⁹ for certain of the Orthoptera.

I had hoped to make out the history of the reproductive system, but as far as can be determined, no trace of these organs is developed until sometime after hatching. In the workers and soldiers (nasuti), both larvae and adult, of this species, the reproductive organs are entirely aborted.

In reference to the general bearings of my study of this form, I shall have something to say in the paper of which this is a preliminary abstract. It may be said here that I do not regard the Libellulids as the best examples of the ancestral type of development among insects, as has been so prominently claimed of late⁴ (Korschelt and Heider). On the contrary, I think that the Termite, and those Orthoptera having a superficial embryo beginning in a disc which must elongate considerably to attain the definitive number of segments, have most nearly adhered to the typical method of development for arthropods, and probably best represent the development of the ancestral insects. My reasons for this cannot be given in this note, but will appear in the full paper.

There is not sufficient space here to discuss the question of the origin of the amnion, but I will say that Wheeler's⁹ adaptation to insects of Ryder's theory of a mechanical origin of the membranes of vertebrates seems a most inadequate explanation. (Of course the word "mechanical," as used here, is used in the narrow sense of the term, referring the subject to simply stated conditions of pressure and mechanical strain.) This theory is opposed by what we know of the development of the Crustacea, the Myriopods and the Apterygota. As far as can be shown, the same conditions of pressure are brought to bear on the developing embryos of these forms as on those of the amniote insects. Yet no amnion is formed. In those higher forms of insects, which are characterized by the non-appearance of membranes, their failure to appear is even more marked. Here, in the very face of the conditions stated to be efficient to produce them, no membranes are developed.

The origin of the amnion is in all probability referable to physico-chemical forces, but at present I do not believe the problem can be stated in more definite terms than as follows: There was a suitable basis among the anamniotic ancestors of winged insects for the formation of membranes, but a further condition was necessary before the amnion should arise. This was a change in the environmental influences, making it a necessity (perhaps for protection against injury, as Korschelt and Heider suggest⁴) for the embryo to be covered over at an early stage in its development. The physico-chemical forces which led to the origin of this adaptive covering cannot be defined at present, but the result was that, as soon as the first rudiment of the embryo, the germ-disc, became established, a portion of it folded over the rest and became the amnion. This would occur most readily in forms which, like some Orthoptera and the Termite, begin in a small germ-disc. When forms arose among the higher insects as adaptations to special conditions of life the early completion of this process became less important, and in a few extreme cases this led to the degeneration and disappearance of the membranes.

¹ Brandt, A. Beiträge zur Entwicklungsgeschichte der Libelluliden und Hemipteren. 1869.

² Bruce, A. T. Embryology of Insects and Arachnids. 1887.

³ Graber, V. Vergleichende Studien am Keimstreif der Insecten. 1890.

⁴ Korschelt and Heider. Lehrbuch der Vergleichenden Entwicklungsgeschichte. 1890.

⁵ McMurrich, J. P. Embryology of Isopod Crustacea. 1895.

⁶ Patten, Wm. The Development of Phryganids. 1884.

⁷ Viallanes, H. Sur quelques points de l'histoire du développement Embryonnaire de la Mante religieuse. 1889-90.

⁸ Wheeler, W. M. The Embryology of Blatta Germanica and Doryphora decemlineata. 1890.

⁹ Wheeler, W. M. Contributions to Insect Embryology. 1893.

¹⁰ Heymons. Development of Orthoptera and Dermaptera. 1895. (Abstracted in Journal of Roy. Mic. Society, 1894.)

The Pholadidæ, II. Note on the Organization of the Larva, and the Post-larval Development of Ship-worms. By C. P. SIGERFOOS.

A year ago I published¹ a note on the early stages of development of the Pholadidæ, in which the breeding habits of Pholas and three species of ship-worms were described. During June and July of 1895 I again visited Beaufort, N. C., with the Johns Hopkins Marine Laboratory, and collected all stages of one of these species (*Xylotrya fimbriata*) from the small bivalve that has just become attached to the adult. As the eggs of this species are extruded freely into the water, I have not been able to observe the stages between the oldest larvae raised in aquaria from artificially fertilized eggs and the attached stage, in which the development is much more advanced. For these intermediate stages it is necessary to resort to species which retain the embryos in the gills.

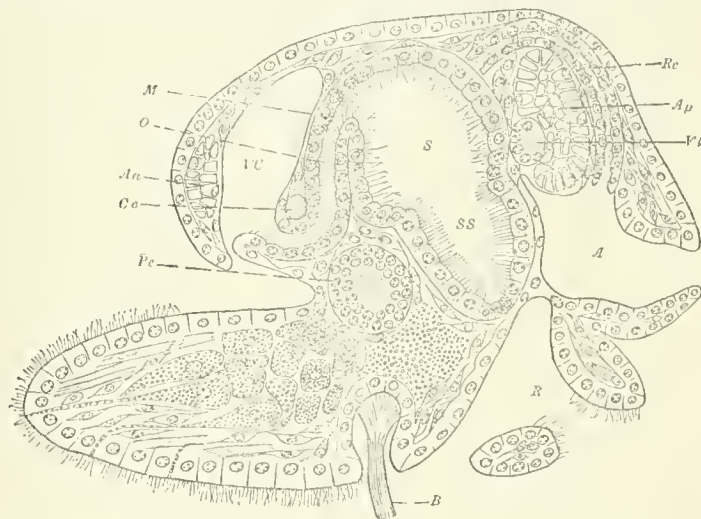


FIG. 1.

The free-swimming stage is reached in three hours, and in a day a well developed shell has been formed. The young of Lamellibranchs develop but slowly, and though we have no direct observations as to the time the ship-worm larva is free-swimming, we may assume, I think, that it is at least a month; it may be two. During this time most of its energies are expended in locomotion, while after it has become attached it may devote all of its energies to forming its burrow and to securing food for itself, so that its rate of growth is very rapid. The larvae become attached very freely to boxes hung in the water, and in this way I was able to secure all stages of development and to observe the rate of growth. I have observed as many as thirty to one sq. cm. of surface. Coming in contact with the wood, the larva throws out a single long byssus thread for attachment, and never again leaves its place. The velum is lost within a few hours, and the transformation of the small bivalve into the ship-worm is begun. The newly attached larva is somewhat less than 25 mm. long. In 12 days it has attained a length of 3 mm.; 16 days, 6 mm.; 20 days, 11 mm.; 30 days, 63 mm.; and 36 days, about 100 mm., when it bears ripe eggs or spermi. In four to five weeks small timbers may be completely ruined in the warm water at Beaufort.

ORGANIZATION OF THE LARVA.

In striking contrast with the adult, the larva (shown in longitudinal vertical section in Fig. 1) is perhaps more foreshortened than that of any

¹ Johns Hopkins Univ. Circulars, No. 119, June, 1895.

other Lamellibranch. The valves of the shell are elliptical in outline, somewhat wider than long. Seen dorsally they are circular in outline. The left valve bears two teeth, the right, three. The long internal process of later stages (aphophysis) is present as a rudiment.

The velum still occupies a large space (*V. C.*) in the anterior dorsal region. I have never seen it extended after the larva had become attached. Both siphons (*A.* and *R.*) are already formed, and from their point of union the septum has grown forwards and become attached to the foot. The gills of this stage have developed but little beyond the last stage figured by Hatchesek. There are on either side two gill slits, with a rudiment of a third. The "filaments" are true gill-bars for they are attached to the foot by their ventral end.

The foot is present as a very long tongue-shaped structure, with a byssus apparatus at its posterior ventral angle. In Fig. 1 the foot is shown considerably contracted, occupied mostly by mucus cells and the byssus apparatus.

The retractors of the foot are attached to the umbonal region of the valves. Both adductor muscles are present, the posterior already the larger of the two. (*Aa.* and *Ap.*).

The nervous system is already highly developed (Figs. 1 and 2). All of the ganglia are well formed and the commissures form well-defined nerves. The cerebral and pleural ganglia are still separated by a short commissure. The pleural (*Pl.*) is lateral to the cerebral (*C.*), and from its posterior angle the pleuro-visceral commissure passes. The pedals (*Pe.*) are as much concentrated as they will become. The otoliths lie lateral to their posterior edges and persist to the adult condition. The visceral ganglia (*V.*) are still wide apart, and lie in front of the posterior adductor muscle (*Vi.*) With their commissure they form a cylindrical mass four or five times as long as its diameter, and somewhat enlarged at the two ends, the ganglia proper. The ganglion of the respiratory nerve (*Rg.*) is still wide apart from the visceral.

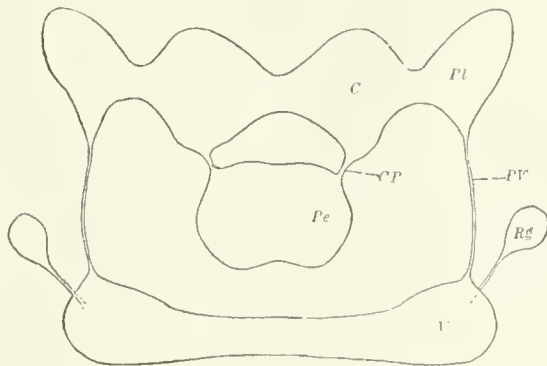


FIG. 2.

The alimentary canal is already highly specialized. A rather long oesophagus (*O.*) leads into the stomach (*S.*), on either side of which a single liver lobule is borne. From the posterior part of the stomach the sheath of the crystalline style (*SS.*) has grown, and though small, its wall is already composed of large, clear, slightly granular cells, bearing long, dense cilia. The intestine leaves the right side of the stomach in front, forms a single loop, and bends upwards and backwards to hang over the posterior adductor (*Re.*). From the middle of the right side of the stomach the caecum has grown as a small hemispherical bag, though it is still functionless.

The renal organs are present and lie ventral to, and in front of, the posterior adductor muscle. Near the cerebral ganglion on either side is a glandular structure which I shall describe later.

METAMORPHOSIS AND ADULT STRUCTURE.

Once attached, the larva probably never leaves its place. The velum is very soon lost, and has an interesting fate. The long lower lip is thrown forward to the mantle in front, under the velar cavity, so that the cells of the velum which are cast off have but one mode of escape, into the oesophagus. They break off from the basement membrane and are eaten. Within a few hours the membrane contracts so as to wholly obliterate the velar cavity. This fate of the velum is interesting, for it has been described as

entering into the formation of the labial palps. But in this species there are no palps, and it would not do to generalize to other forms. However, in the oyster where the palps become very large, they are very small at first, much smaller than the velum, though they are not developed till after the oyster has become attached.

The foot very soon (within a day) becomes the pestle-shaped cupping organ, which assists the shell in boring. The byssus apparatus is functional for a day or two and then degenerates, though it persists in the posterior part of the foot as a small closed vesicle, as in *Cyclas*.

The burrow is formed as follows: Almost as soon as the larva has settled, it begins to clear away a place by means of the ventral edges of the valves of the shell. In this way a small pit is formed. But very soon rows of teeth are formed in succession on the anterior edges of the valves; the small knobs are formed on their umbonal and ventral regions; the ligament becomes functionless, and the two adductors become antagonistic to each other. The teeth are formed independently, and afterwards are cemented to the valves, pointing outward and backward. While the foot performs a cupping action, the posterior adductor contracts, the two valves swing on each other by means of the two pivots formed by the knobs, and the teeth are brought to bear on the wood, rasping away its surface.

The essential changes in the nervous system are the fusion of cerebral and pleural ganglia, and the concentration of the viscerals, and their shifting in position. The cerebrals and pleurals have fused in specimens 5 mm. long, but their double origin is still indicated. The visceral ganglia become concentrated in specimens 1 mm. long, and shift from a position anterior to the posterior adductor to one ventral to it, and at last come to lie far behind it in the adult. It seems interesting that the description of the nervous system given by Quatrefages¹ is still accepted, except with slight modifications in the viscerals as given by Pelseneer. Quatrefages described the cerebral ganglia as fused, the pedals as rudimentary and separate. On this ground, with others, he proposed to separate the Terebridae from the Pholadidae. He mistook the pedal for the cerebral, but I am unable to say what he described as the pedal. The pedals are fused from the first, and never become rudimentary, though their development is not nearly so great as that of the visceral. The cerebro-pleurals remain separated by a long commissure, and lie almost at the sides of the mouth.

The gills of the ship-worms are more specialized and more interesting than has heretofore been supposed. Beginning with the two "filaments" present in the larva, new filaments are added posteriorly by the appearance of slits in the gill fold. These filaments are in reality bars, for the slits are perforations which do not penetrate to the ventral border of the fold. The fold progressively fuses with the body at its ventral border. In this way a series of bars is formed, attached at both ends. This mode of formation persists through life, except that after the tenth (usually) a second slit appears ventral to the first, so that each filament is separated from its fellows by double slits. That last formed corresponds to the space between the ascending limbs of adjacent filaments. The first ten filaments, then, have no ascending limbs. Deshayes described² a series of plications in the anterior part of the body, and thought them to be normal structures. These are the first ten filaments formed, which have later become separated from their fellows posteriorly by a great distance, as follows: When the young *Toredo* is somewhat less than 1 cm. long, each gill consists of a long series of about seventy-five filaments, stretching uniformly from the anterior part of the body to the small filaments which have just been formed. But now the ninth or tenth filament broadens (grows in line of the antero-posterior axis of the animal) till in large specimens of the adult the anterior filaments may be separated from the posterior part of the gill by ten cm. or more. The ciliated furrow described by Deshayes connects the two portions. The epibranchial cavity persists as a long canal between the two parts. Fusions between adjacent filaments of the first ten take place so as to more or less obliterate the gill slits.

Contrary to the statement of Quatrefages, there is a single gill (a half etenidium in modern usage) on either side. This is the internal gill, and the external has wholly disappeared.

Closely associated with the gill is a very prominent glandular structure peculiar to the ship-worms. Deshayes described a special gland in the um-

¹ Annales des Sciences Naturelles, Zool. Ser. 3, T. 11.

² Histoire naturelle des Mollusques.

bonal region, and surmised its function to the formation of a secretion for softening wood by chemical action. Grobben¹ did not find it, and questioned its existence. Deshayes also described mucus glands in the gills, whose secretion he supposed to be for the nutrition of the embryos in these viviparous forms. Both are parts of the same organ. In the newly-attached larva there is a considerable glandular structure on either side in the anterior part of the body, whose duct opens under the cerebral ganglion in front of the mouth. As the animal grows, the gland grows posteriorly, sending branches into the gill filaments. As the two parts of the gill become separated, the two parts of the gland remain connected by a long, narrow (? functionless) duct, which accompanies the epibranchial canal. Further than this I am at present unable to describe this organ, which is very difficult to study. Since in this species which does not retain its embryos, the posterior part is present in young and old, and in males and females, its function cannot be the formation of a secretion to nourish the embryos.

The posterior part of the body, usually called the muscular collar, is a very interesting region, containing a complex of several well-defined muscles. The collar is attached to the calcareous tube in an irregularly elliptical line. The outermost part is the line of origin of the *protractor of the pallet*, which radiates from the inner end of the handle of the pallet, its insertion, to its line of attachment. To the inner line is attached the *retractor of the siphons*, which is almost wholly distributed to the respiratory siphon. A well-defined muscle, the *adductor of the pallets*, connects the upper parts of the handles of the pallets. From the upper end of the handle a small muscle, the *retractor of the pallet*, passes to the body forwards. The animal defends itself as follows: While the siphons are retracted, the pallets are protracted to completely close the tube at its outer end. The siphons are extended by an inflow of blood, and the pallets are retracted by the action of their retractors, accompanied by the adductor of the pallets.

In specimens 3 mm. long, in which the visceral ganglia have taken up the position of the adult, the sexual organ is present on either side as a rudiment of a small mass of cells ventral to the ganglia. From this part branches grow out, and the lumen appears later. That in the oldest part of the gland becomes the main part of the genital duct. In addition, there is in the genital papilla a small ectodermal invagination which much later unites with the part which is of mesodermal origin. The part which is of mesodermal origin forms sexual cells, at least at first. The sexes are separate from the first. Protandry is not present. Only rarely are individuals hermaphrodite.

The ship-worm larva is already highly organized when it becomes attached. A functional byssus apparatus is present. The cells of the velum are cast off and eaten. The cerebral and pleural ganglia are still separate. The crystalline style arises from the posterior part of the stomach. While the foot performs a cupping action to draw the shell close against the surface of the wood, the contraction of the posterior adductor muscle causes the two valves to swing upon each other, and the teeth rasp away the wood.

Contrary to the description of Quatrefages, the pedal ganglia are not separate and not rudimentary; the cerebrals are not fused, but separated by a long commissure. The first formed filaments of the adult gill have no ascending limbs. They form a series of bars in the anterior region of the body, separated from the rest of the gill by a long distance. Only the inner gill is present. Anteriorly in the umbonal region, and closely associated with the gill posteriorly, is a prominent organ of unknown function. The sexual duct is mainly of mesodermal origin.

EXPLANATION OF FIGURES.

FIG. 1.—Longitudinal vertical section of newly attached ship-worm. The disintegrated cells of the velum are not shown.

FIG. 2.—Outlines of the ganglia of nervous system, dorsal view. Only commissural nerves are shown.

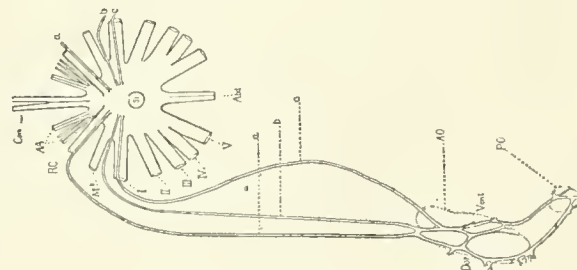
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|--------------------------------|------------------------------------|
| A.—Anal siphon. | Pe.—Pedal ganglion. |
| Aa.—Anterior adductor muscle. | Pl.—Pleural ganglion. |
| Ap.—Posterior adductor muscle. | R.—Respiratory Siphon. |
| B.—Byssus thread. | Rg.—Ganglion of Respiratory Nerve. |
| C.—Cerebral ganglion. | S.—Stomach. |
| Ce.—Cerebral commissure. | SS.—Sheath of Crystalline Style. |
| Cp.—Cerebro-pedal commissure. | V.—Visceral ganglion. |
| M.—Basement membrane of Velum. | Vc.—Visceral Commissure. |
| O.—Oesophagus. | Vc.—Velar Cavity. |

The Inhibitory and Accelerator Nerves to the Crab's Heart.

By F. S. CONANT and H. L. CLARK.

At the suggestion of Professor Howell, the writers undertook to repeat on the American Crab (*Callinectes*) some of the work of Plateau and of Jolyet and Viallanes on European crustaceans. Our observations support the conclusions of the latter, and supplement them by tracing out the course of the cardiac impulses from the central nervous system to the heart. Three pairs of nerves were found arising anteriorly from the dorsal surface of the thoracic ganglion, and passing backward to a plexus on each side within the pericardium. From each plexus fibres pass into the heart. Of the three pairs of nerves, the most anterior leave the ganglion with the recurrent cutaneous nerves, and are inhibitory in their function. The other two pairs leave the ganglion with the third maxilliped and first ambulatory nerves respectively, and carry accelerator fibres to the heart.

The full account of the work may be found in Vol. I, No. 2, of "The Journal of Experimental Medicine."



To illustrate the course of the accelerator and inhibitory nerves from the thoracic ganglion to the pericardial plexus in *Callinectes hastatus*. The ganglion is drawn from the dorsal side. The plexus is laid over on its left side; in its natural position it lies in a plane at right angles to that of the ganglion. Com., oesophageal commissures, passing to cerebral ganglion; AA, nerves to the anterior appendages; RC, recurrent cutaneous nerve; M³, nerve to the third maxilliped; I, II, III, IV, V, nerves to the legs; Abd, nerve to the abdomen; St, sternal artery; a, inhibitory nerve; b and c, accelerator nerves; AO, anterior branchio-cardiac orifice; PO, posterior branchio-cardiac orifice; Dor, dorsal; Vent, ventral aspect of plexus.

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¹ Arbeiten Zool. Inst. Wien, Bd. 7, 1886.

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PROCEEDINGS OF THE SCIENTIFIC ASSOCIATION OF THE JOHNS HOPKINS UNIVERSITY.

One Hundred and Twenty-sixth Regular Meeting, March 19, 1896.

The President of the Association in the Chair.

The following papers were presented and read :

1. The Geology of the Cascade Mountains. By BAILEY WILLIS.

In the Cretaceous period Puget Sound and adjacent areas of Washington and Oregon of indeterminable extent were beneath a sea in which limestone was the principal formation. It is probable that toward the north or north-east in northern Washington and British Columbia, there was a low land area consisting largely of gneissic and metamorphosed crystalline rocks. There gradually ensued a change by which Puget Sound and the area where the southern Cascades now extend from the 48th parallel southward through Oregon became an extensive estuary, in whose waters deposits of sand and mud were laid down, and around whose changing shores there were many marshy lagoons in which a rank vegetation flourished. The conditions of estuarine deposition, which perhaps can be best exemplified by pointing to our southern Atlantic coast, endured throughout Eocene and Miocene times, and we know that in the Miocene the climate was tropical and the place of the Cascade Range was a swampy lowland near sea level. The thickness of sandstones, shales, and coal beds of the Puget group is 7,000 to 12,000 feet or more.

The accumulation of this depth of sediment in a shallow estuary implies a corresponding subsidence of the bottom of the estuary. Moreover, the gathering of the sediment for these deposits from adjacent land areas, which were throughout that period prevailingly low, obviously indicates a corresponding rise of the lands. Thus during all this epoch of the accumulation of the Puget Sound coal series, not only were the agencies of the air and sea at work making the records, but the levels of the earth's mass were gradually changing in a proportionate manner. At some epoch in or soon after the Miocene, the hitherto quiescent earth became energetically active, and the activity took on two quite distinct forms. There rose along the western coast an annulus, which became a mountain range. In extent it reached from some unknown northern limit far in British Columbia, southward to Mount Shasta in California. In width it reached 100 or possibly 150 miles; and in height over wide areas it attained an elevation of 7,000 feet. The growth of this annulus—that is, the growth of the mass of the Cascade Range—was probably not convulsive or catastrophic, but was, nevertheless, as compared with previous movements of the earth's mass in that region, rapid, and therefore the resulting range became a broad swelling of the earth's crust, attaining a somewhat uniform elevation over extensive areas. The streams originally existing within this area were undoubtedly changed in their courses and new streams were developed down the slopes, and these—all of them having greatly accelerated falls—went vigorously to work to saw canyons in the rising mass. They developed an acute and varied relief, consisting of a great central mountain range with many radiating spurs, all of the valleys being characterized by V-shaped cross sections, and the heights by pyramidal forms.

With the uplift and possibly antedating it in the earlier manifestations of activity, there were outbreaks of volcanic energy, and these outbreaks were of very great volume and no doubt of extremely violent action. The volcanic rocks of the Cascades form a very large proportion of the mass of the range. The extinct craters are numerous and attractive features of the scenery, and the gigantic cones which were piled up about the principal outlets, such as Mount Baker and Mount Rainier, are the grandest monuments of the mountain building forces in this country.

At a comparatively recent time the Cascade region shared in the glaciation of the northern part of our country, but not in the degree with which New England or northern Alaska shared in it. The development of glaciers in the Cascades was local. They never covered the highest summits, but every valley contained its ice river flowing from the gathering grounds of the snow among the high peaks. The effect of such glaciation upon the scenic aspect of the region is quite different from that of a continental glacier. Whereas the continental glacier grinds off and planes down all eminences and

reduces the topographic configuration to a tame and rounded aspect, the development of glaciers in the valleys accentuates all relief. The V-shaped valleys of stream-carving become U-shaped with precipitous sides, the pyramidal peaks become concave in their slopes, and the extreme pinnacles become tooth-like spires. Thus the student of physiography in the Puget Sound and Cascade region in the sedimentary record reads of the time when there were no mountain ranges and the whole area of western Washington was either plain or low marsh or shallow estuary, in the existing differences of elevation of the mass of the Cascades and the depth of Puget Sound observes evidences of the growth of a mountain range, in the huge snow-capped mountains towering many thousand feet above the general elevation of the range discovers the monuments of volcanic activity, and in the savage grandeur of the precipitous amphitheatres and pinnacles notes the handiwork of the frost king, whose carving is the latest work of Nature's sculptors.

2. Investigations upon the Electric Discharge in High Vacua.

By N. R. CARMICHAEL.

When the electric discharge passes through very high vacua the striated positive column, which plays such an important part in the ordinary Geissler tube discharge, no longer appears; the negative glow and other appearances in the neighborhood of the cathode are also greatly modified, and the chief interest now attaches to the cathode rays. These invisible radiations leave the surface of the cathode at right angles, and move away in straight lines until they fall upon some object which absorbs them and which they render fluorescent. Their nature has been much discussed, and two theories have been advanced. Crookes, their discoverer, thought them streams of negatively charged particles of matter; Hertz and Lenard have considered them vibrations of the ether. The former view is now almost universally believed, as many experiments contradict the latter. The velocity of the cathode rays (2×10^7 centimetres per second) is less than one thousandth of that of light; they are deflected by a magnet exactly as negatively charged particles moving with their velocity should be; finally, they have been found by M. Jean Perrin to carry a definite negative charge.

The high vacuum is also the source of the "new kind of rays," recently discovered by Professor Röntgen, whose strange power of penetrating all substances has excited so much popular interest. The Röntgen rays resemble light and cathode rays in their power of exciting fluorescence and affecting photographic plates. Unlike light, they are not appreciably reflected or refracted; unlike the cathode rays, they are not deflected by a magnet; while unlike both light and cathode rays, they discharge positively and negatively electrified conductors, apparently by their action not upon the conductor, but upon the surrounding dielectric. As to their nature, it is impossible at present to do more than guess. They may be material particles or either longitudinal or transverse waves of very short wavelength, the latter view seeming more probable.

One Hundred and Twenty-seventh Regular Meeting, April 30, 1896.

The President of the Association in the Chair.

The following papers were presented and read :

1. The Flow of Glaciers. By H. F. REID.

A consideration of the snow accumulated and the ice melted, leads to the conclusion that the quantity of ice flowing through a section of a glacier is greatest at the *névé*-line, and diminishes as we ascend or descend the glacier from this point.

In the reservoir the direction of flow is into the glacier; in the dissipator it is towards the surface. A diagram of the direction of flow throughout the body of the glacier can be drawn, which shows a relation between the form of the reservoir and the distribution of moraines on the lower part of the glacier.

The curved form of the ends of most Alpine glaciers, and the overhanging ends of some Greenland glaciers, are dependent on a relation between the

velocity of flow and the rate of melting at different distances from the bed of the glacier, and in the latter case also on the strength of the ice.

Glaciers are rarely in equilibrium with their surroundings. The form of the surface of the Alpine glaciers corresponds to a form of *unstable* equilibrium, and therefore the known considerable variations in the length of these glaciers could be predicted.

2. On the Law of Parallelism of Axes of Rotation, and on Gyroscopic Motion. By A. S. CHESSIN.

Dr. Chessin gave a short account of the so-called law of parallelism of axes of rotation enunciated by Sire, and showed that it is incorrect. He specially insisted upon the necessity of solving problems of mechanics rigorously in order to avoid erroneous conclusions as exemplified in this pseudo-law of Sire. He also gave some results of his researches upon the motion of gyroscopes.

The following papers of research were then presented and read by title:

1. On the Motion of a Homogeneous Sphere on an Inclined Plane, taking into account the Rotation of the Earth. By A. S. CHESSIN. (*Bull. Am. Math. Soc.*)
2. On Singularities of Single-valued and generally Analytic Functions. By A. S. CHESSIN. (*Univ. Circ., J. H. U.*)
3. On Gyroscopic Motion. By A. S. CHESSIN. (*Univ. Circ., J. H. U.*)
4. On a Particular Case of Motion of Gyroscopes in the apparatus called the Polytrop. By A. S. CHESSIN. (*Univ. Circ., J. H. U.*)

The Letter of an Assyrian Princess. By CHRISTOPHER JOHNSTON.

[Abstract of a paper read before the University Philological Association, May 15, 1896.]

For the history of the concluding years of the Assyrian Empire, and the succession of the last Assyrian Kings, cuneiform material is extremely scanty. Although the brilliant reign of Ašurbanapal (668–626 B. C.), the Sardanapalus of Greek writers, is illustrated by a very large number of inscriptions, the events attending the latter part of that monarch's rule are involved in obscurity. On his death, in 626 B. C., after a reign of forty-two years, he was succeeded by his son, Ašur-etil-ilāni-(-ukinni), of whom but few memorials have as yet been discovered. In a brief inscription found at Nimrūd, the biblical Calah (Gen. 10, 11), he calls himself the son of Ašurbanapal, and the grandson of Esarhaddon, but merely refers to building operations in Calah.¹ In 1889 three contract tablets of the reign of this king were found by the American expedition at Niffer, in Babylonia, the latest of which is dated 1st of Marcheshvan, 4th year of Ašur-etil-ilāni, King of Assyria.² He must therefore have reigned until at least 622 B. C., but how much longer there is at present no means of determining.

The late George Smith states (Assyrian Discoveries, p. 384) that, according to a "broken record" discovered by him, this prince did not succeed to the throne immediately upon the death of his father, Ašurbanapal, but ascended it later. No such text, however, is now known to exist, and the accuracy of Smith's rendering may well be doubted.

The last King, of whom any information is to be derived from cuneiform sources, was Sin-šar-iškun, who is supposed to have been the son and successor of Ašur-etil-ilāni. He is usually identified with Sarakus, mentioned by Abydenus, on the authority of Berossus, as the last King of Assyria, in whose reign occurred the destruction of Nineveh.³ A number of his inscriptions have been found, but all are mutilated or fragmentary, and yield little information.⁴ A contract tablet published in Schrader's *Keilinschriftliche Bibliothek* (iv, 176), is dated in the seventh year of his reign.

Such, briefly stated, is all that is known from cuneiform sources regarding the last monarchs of the Assyrian Empire, and, as may be supposed, every scrap of information about this interesting period is eagerly sought for by scholars.

For this reason a tablet of thirteen lines, published in *The Cuneiform Inscriptions of Western Asia* (Pl. 16, No. 2), has received considerable attention. Professor Sayce, who first translated the text in his *Babylonian Literature*, considered it a spelling lesson "received by one of the granddaughters of Ašurbanapal, who is told not to write *umpici*, or to say *impuci*." His translation of the opening lines reads as follows: "The prayer of the daughter of the King to the lady of the city of Asshur the queen: why *umpici* dost thou not write? *impuci* dost thou not say?"⁵ It is, however, hardly fair to criticize a translation made by Professor Sayce some twenty years ago, which he would certainly not defend at the present time.

Professor Fritz Hommel, of Munich, in his *Geschichte Babylonien und Assyrien* (Berlin, 1885, p. 694, n. 4), gives a translation of the text which he considers a report from the servant of the daughter of the king to the lady ^{Al}Assur-scharrat. He must have read here *abad*, and taken the word as the construct of *abdu*, 'servant,' but this is impossible. *Abdu* is in any case an extremely rare word, and the correct reading is certainly *abit*, the construct of *abitu*, 'will, command.'¹ Hommel's rendering is as follows: "Du sollst deine Tafel nicht (mehr) schreiben, den Spruch (ald) deines imbu (Pensum's) nicht mehr sprechen, und nicht Sollen sie mehr sagen: ist diese (eben die angedete) die Schwester der Siru-tirar, der grossen Tochter des Harems (bit ridūti) des Assur-til-ildni-ukinni? Noch (sollen sie mehr sagen): Du bist die hehre Tochter, die Herrin des Hauses Assurbanipals, des grossen Königs-sohnes des Harems (bit ridūti) des Asarhaddon, Königs von Assyrien."

Hommel remarks in explanation that, in this text, hitherto misunderstood, the daughter of King Ašur-etil-ilāni-ukinni orders the expulsion, from the harem, of her older relative.

Hommel's translation, however, contains a number of manifest errors, and it can hardly be said that he himself understood the true meaning of the text.

Professor C. P. Tiele, of Leyden, in his *Babylonisch-Assyrische Geschichte* (1886, pp. 406, 413), correctly describes the letter as referring to a dispute about precedence (*Rangstreit*) between two ladies of the palace, but, with his usual caution, does not translate it.

In 1888, the late Arthur Amiaud, the distinguished French scholar whose early death was a great loss to Assyriology, made this text the subject of a paper in the *Babylonian and Oriental Record* (ii, 197 ff.), and gave the following version: "Order of the daughter of the King to ^{Al}Asshur-sharrat. No longer write thy tablets, and no longer speak thy words! Lest they should say thus: 'This is she then the mistress of Šerua-eterat, great princess of Bit-ridute, daughter of Asshur-etil-ilāni-ukinni, great king, powerful king, king of nations, king of Assyria?' But thou, thou art the powerful princess, the mistress of the house of Asshur-ban-abil, great prince of Bit-ridute, son of Asshur-ah-iddin, King of Assyria."

Amiaud calls attention to the fact that the opening words of the letter—*abit marat šarri*, literally 'the will (or command) of the King's daughter'—distinctly mark the superiority of the writer over the person addressed. Indeed, in all other instances where this form of expression occurs, it is employed by the king in addressing his subjects or servants. From this and from the whole tone of the letter, the French savant argued that it could hardly have been addressed by a young princess to her grandmother or aunt—for such would be the relationship if this rendering be correct—and found further difficulty in the fact that Ašurbanapal is only described as 'great prince of Bit-ridute,' while Ašur-etil-ilāni and Esarhaddon both receive the title of king.

On these grounds he proposed a genealogical table, in which the lady to whom the letter is addressed is represented as the wife of a prince Ašurbanapal, hitherto unknown, son of an Esarhaddon II, whose existence had previously been asserted on other grounds by Sayce and Schrader, of whose views Amiaud considered this text a confirmation. According to this ingenious hypothesis, Šerua-eterat, the writer of the letter, would be sister

¹ KB, ii, 268.

² Cf. Hilprecht in ZA, iv, 167; Harper in *Hebraica*, vii, 79.

³ Cf. BA, iii, 113.

⁴ Cf. Schrader, in *Berichte der K. Sächsischen Gesellschaft der Wissenschaften*, 1880, *Phil.-Hist. Classe*, pp. 1 ff.; Winckler, in *Revue d'Assyriologie*, ii, 66.

⁵ Sayce, *Babylonian Literature*, pp. 19, 78.

¹ Cf. Delitzsch, BA, i, 188.

to Esarhaddon II, and her correspondent the wife of her nephew. In this case the letter must have been composed in the reign of Esarhaddon II, and Amiaud admits his inability to explain why the writer calls herself the king's daughter and not the king's sister. But Amiaud's explanation, and the historical hypothesis he founds upon it, are certainly untenable.

The theory of the existence of an Esarhaddon II has long been abandoned by all Assyriologists, with the single exception of Professor Sayce, and any lingering doubt which may have existed upon the subject must be effectually dispelled by the texts published in Kundtson's *Gebete an den Sonnengott* (cf. especially p. 68 ff.). Moreover, while Amiaud has certainly comprehended the general meaning of the text, his translation of the important line (l. 11), which gives the relationship between the parties, and thus contains the gist of the whole letter, rests, like that of Hommel, upon a manifest grammatical error. *Mārat dannat belit bīti ša Ašurbanapal* cannot mean 'the powerful princess, the mistress of the house of A.' *Mārtu* does not mean 'princess,' but 'daughter;' nor can it be qualified by *dannat*, since such an interruption of the construct relation by an adjective is opposed to the whole usage of the Assyrian language. Neither can it be coördinated with *belit bīti*, since two coördinated constructs can never depend upon a single genitive. Such a barbarous construction is, from both points of view, opposed to all the rules of Assyrian grammar and the analogy of the other Semitic languages.¹ It is clear, therefore, that the words can only be construed as a single construct chain, the length of which necessitates the use of *ša*, the sign of the genitive, before the nomen rectum. But the reading *dannat* does not suit the context, and it would seem to be evident that *kallāt*, 'daughter-in-law,' is here intended. This involves no alteration in the Assyrian text, and *kallāt*, written in precisely the same way (*kal-lat*), occurs in Strassmaier, AV, 8827, Nbn, 253, 9. The words must mean, therefore, 'the daughter of the daughter-in-law of Asurbanipal's wife.'

The relationship may appear somewhat involved, but the princess doubtless had her reasons for laying stress upon it. The words *belit bīti* (l. 11) rendered by Amiaud literally as 'mistress of the house,' might mean simply 'member of the household, or family.' A parallel expression is to be found in *bel qinni* 'member of the family' K. 595, No. 3, and analogous uses of *belu* are common in Assyrian. For *bītu* 'house' in the sense of 'family,' may be compared the expression *zer bīt abišu*, literally 'the seed of his father's house,' Asrb. III, 61. It is better, however, to take *belit bīti* as a fixed term meaning the legitimate wife, as opposed to a concubine. This is illustrated by several passages in the contract tablets where the purchaser of a piece of property gives to the seller, over and above the full price, a sum of money as a bonus (*atru*), and a dress for the *belit bīti*, i. e. for his wife, since no other interpretation would suit the context (Cf. Strassmaier, Nbk, 4, 13-14; Cyr. 345, 26-27; Peiser, *Bab. Verträge*, xciv, 15-16; cxvii, 20; Zehnfund, ZA, I, 513, n.). This custom, which symbolized the completion of the bargain, may have been a sort of recognition of the wife's right of dower. The King's principal wife, or queen, seems to have been styled more specifically, *zikrit ekalli* 'the lady of the palace,' and to have had her own separate establishment, as also her own officers and attendants.²

In ll. 3-4, both Amiaud and Hommel take the verbs as imperatives, but this is not necessary; they may be just as well construed as presents, which, indeed, suits the context better.

In l. 3, both scholars read *tašāfirī*, from *šašāru* 'to write;' but the present of *šašāru* is not *tašāfirī*, but *tašāfar*, and we must read here *tasādīrī*, from *saddru* 'to arrange, put in order,' to which stem the word is referred in Delitzsch's *Handwörterbuch*. The words *duppikī lā tasādīrī* mean literally 'thou dost not arrange thy tablet,' i. e. 'thou dost not draw it up in proper form.'

Amiaud is doubtless right in deriving *imbu* (= *imbū*, l. 4) from the verb *nabū*; but *nabū* means not 'to speak' but 'to call' or 'to name,' and its derivative *nibūtu* means 'name,' so that *imbū* can hardly signify 'word.' 'Title' would be a better rendering, and the words *imbūki lā taqābī* may very well mean 'thou dost not use the title befitting thy station' literally, 'thy title.'

In l. 6, we have, of course, the interrogative enditic *u*, as was recognized by Hommel. In the same line Amiaud's hypothesis required that the ideogram NIN should be read *belu* 'lady, mistress,' but *axātu* 'sister' is certainly the correct reading.

It seems to me, therefore, that the text should be transliterated and translated as follows:

Abūt mārat šarri ana

Sul. Al. Aššur-šarrat!

Atā duppikī lā tasādīrī,

imbūki lā taqābī.

5. *Ulā iqābūā*

mā: 'Annūtū axātsa

ša¹al. Šerū'a-eterat

Mārtu rabūtu ša Bīt-ridūte

ša Ašur-etil-ilāni-ukīnni,

10. *šarru rabū, šarru dannu, šar kiššati, šar māi Aššur?'*

U attī mārat kallāt belit bīti ša Ašur-ban-apal,

Mār-šarri rabū ša Bīt-ridūte,

ša Ašur-axa-iddina šar māi Aššur.

Translation.

Message of the King's daughter to Asshur-sharrat! Thou dost not (properly) address thy letter (sent to me), nor use the title (befitting thy station).¹ (People) might say: 'Is this the sister of Šerū'a-eterat, the eldest daughter, of the Bīt-ridūti, of Ashur-etil-ilāni-ukīnni, the great king, the mighty king, king of hosts, king of Assyria?' But thou art (simply) the daughter of the daughter-in-law of the wife of Asurbanapal, eldest son, of the Bīt-riduti, of Esarhaddon, King of Assyria.

The lady Aššur-šarrat seems to have written, to the princess Šerū'a-eterat, a letter in which she addressed her as 'sister,' a familiarity which the latter, in the present letter, resents as an impertinence, and refers the indiscreet lady to her proper place.

That she was quite right in her contention is borne out by what we know of Assyrian epistolary etiquette. Šamaš-šum-ukīn could address his brother Sardanapalus as 'my brother,'² but he, as King of Babylon, was a sovereign prince, and therefore upon terms of equality. Sennacherib invariably addresses his father Sargon as 'the king, my lord,' never as 'my father,' and is himself addressed as 'prince' (*mār-šarri*) (PSBA, xvii, 220-239). Ummanaldas, King of Elam, addressed Ašurbanapal as 'my brother' (K, 359), and a number of similar instances could be cited from the Tel-el-Amarna letters, occurring in all cases between independent sovereigns. Among private individuals, except in case of very near relatives, it was the invariable rule to address each person by his proper title, with the addition of the words 'my lord.' If, therefore, Aššur-šarrat addressed the princess as sister, without being so related, she certainly committed a gross breach of etiquette, and was guilty of an impertinence which richly merited a rebuke. Even if she were actually her sister, it is doubtful whether she could have so addressed the *mārat šarri rabūtu ša Bīt-ridūti*.

This last title opens up an interesting question. The *Bīt-riduti* or House of Dominion was, as we learn from the Annals of Asurbanapal (Asrb., x, 51-54), that portion of the royal palace of Nineveh in which the kings of the Sargonide dynasty had their residence. Built by Sennacherib, and subsequently repaired or restored by his successors Esarhaddon and Asurbanapal, it is frequently mentioned by the latter monarch in terms of pride and affection. Here his grandfather Sennacherib dwelt as prince and as king; here his father Esarhaddon was born, brought up and ruled over Assyria; here Asurbanapal himself was brought up and educated in every princely accomplishment. Here also he received his solemn investiture as crown-prince of Assyria (Asrb., i, 11 ff.; Lehmann, *Samassumukin*, ii, 25, col. ii), and his official introduction into the Bīt-ridūti seems to have formed an important part of the ceremony. So important, indeed, did he himself consider it, that in his longest and most elaborate inscription, recording the events of his reign, he deliberately selects the title of *mār šarri rabū ša Bīt-ridūti*, 'great prince of the Bīt-ridūti,' in preference to the usual official title of Assyrian kings, 'great king, mighty king, king of hosts, king of Assyria,' which, however, he employs in other inscriptions. It need not, therefore, surprise us that, in the text which forms the subject of this paper, the princess Šerū'a-eterat styles her grandfather by the title upon which he himself lays so much stress, and Amiaud's objection in regard to this point would hardly seem to be well founded.

¹ Literally, 'thy title.'

² Cf. Lehmann, *Samassumukin*, i, 25; ii, 58.

¹ Cf. Delitzsch, *Assyrian Grammar*, § 123; Gesenius, *Hebrew Grammar*, § 128, 1.

² Cf. Delitzsch, BA, I, 615.

From a text published in Knudtzon's *Gebete an den Sonnengott* (No. 107), we learn that the oracle of the Sun god was consulted in reference to the proposed introduction of Siniddinapal, another son of Esarhaddon, and a brother of Ašurbanapal, into the Bit-ridūti, but as to his subsequent fate we are not informed. If he was actually named as successor to the throne, he must have died in his father's lifetime. Knudtzon (o. c. ii, 220) suggests that the ceremony of introduction into the Bit-ridūti may have had, in itself, nothing to do with the succession to the throne. This is quite possible; it may, for example, have constituted merely a formal recognition of legitimacy. But whatever the significance of the ceremony, the title *mār šarri rabā ša Bit-ridūti* certainly meant, in case of Ašurbanapal at least, the crown prince, the legitimate and formally recognized successor to the throne. It is most striking, therefore, to find the same title assumed by Šerū'a-eterat, the granddaughter of Ašurbanapal. Was it merely the usual title of the eldest daughter of the King? Was it indicative of some special, but merely complimentary, honor conferred upon her? Or is it possible that King Ašur-etil-ilāni had, perhaps through failure of male heirs, formally recognized his daughter as his successor? The last suggestion is, I admit, rather startling, and is not borne out by other evidence. Neither cuneiform inscriptions nor tradition speak of a queen of Assyria in the last days of the Empire, and had any rumor of the sort been extant, it could hardly have escaped the notice of the Greek writers. That our princess succeeded, therefore, is highly improbable; that she may have been named as successor to the throne, without, however, actually succeeding, is at least conceivable. Such an event, if it really occurred, might even have caused a revolution, and thus contributed to the downfall of the Empire in 607-6 B. C. But of all this there is no evidence; and moreover a *mārāt šarri ša Bit-ridūti* 'a princess of the Bit-ridūti,' who was probably a daughter of Esarhaddon, is mentioned (without, however, the adjective *rabitu*) in Knudtzon's texts (No. 29). It seems most probable, therefore, that the designation *ša Bit-ridūti* was applied to those children of the King whose legitimacy was formally recognized, and it may have corresponded, in a measure, to the epithet *πορφυρογέννητος* as employed in the Byzantine Empire. I prefer, therefore, to render the words *mārāt šarri ša Bit-ridūti* 'the eldest daughter of the King, of the Bit-ridūti.' As to the princess Šerū'a-eterat, except the fact that she had an aunt who bore the same name, all that is known is supplied by the present letter. It is impossible to arrive at any safe conclusion as to the personality of Aššur-šarrat to whom the letter is addressed, though many hypotheses might be suggested. The expression 'daughter of the daughter-in-law of Ašurbanapal's wife' is certainly peculiar and may contain some special point, the keenness of which escapes us owing to our ignorance of the family relations and court gossip of the later Sargonide monarchs.

Maitre Adam d'Arras and the Beginnings of French Comedy. By A. RAMBEAU.

[Abstract of a paper read before the University Philological Association, May 15, 1896.]

The *trouwe*, Maître Adam d'Arras, or de la Hale,—about 1235-1288—holds a peculiar position in the history of French literature: He is the author of the first two purely profane dramas, *Li gieu de Robin et de Marion* and *Li jus Adam*. These two dramas are far superior in originality and literary value to all other dramatic productions of the middle ages and in the beginning of modern times in France, save the famous *Farce du Maître Pierre Pathelin* (about 1470). These plays are the more remarkable, because their author seems to have had neither predecessors or models nor followers or imitators. *Le jeu de Robin et de Marion* has rightly been called the first *pastorale* (*comédie pastorale, drame pastoral*) and, at the same time, the first *opéra-comique*. It shows no trace of any influence of Italian music and literature, although the poet probably wrote his play in Italy, where he died before 1288. *Le jeu d'Adam* certainly deserves the name of the first comedy in France, but differs much, especially at first sight, from the later *moralités, farces, and soties*. It is separated from this rich growth of profane plays by a long intervening period surprisingly sterile in dramatic literature, unless we assume that a considerable number of profane dramas originated at that time, which were either lost or so thoroughly transformed by the work of successive generations of playwrights and actors as to appear in their present literary form as original productions of the fifteenth and sixteenth centuries.

Adam de la Hale was, during life, and for some time after death, highly esteemed and honored as a musician and as a poet, not only in his native country (that part of Northern France where the language of the *trouwe*, the Picard dialect, was spoken, written and fully understood), but also throughout France in general. He owes his reputation at the present day chiefly to his music, and to his two dramas, which we moderns are most ready to appreciate. But his contemporaries admired his other poetical works as much as his plays, and perhaps more. We can conclude this from the following verses (80-93) of *Li jus du pelerin*, which, being the prologue of *Li gieu de Robin et de Marion*, used to be ascribed to Maître Adam himself, but which was written almost beyond doubt shortly after the poet's death by one of his friends and countrymen:

Rogaus. Taisiés-vous, Warnier; il parole
De Maistre Adan, le clerc d'onneur,
Le joli, le largue donneur,
Qui ert de toutes vertus plains;
De tout le mont doit estre plains.
Car mainte bele grace avoit,
Et seur tous bian diter savoit,
Et s'estoit parfaiz en chanter.
Warniers. Savoit-il dont gent enchanter?
Or pris-je trop mains son affaire.
Rogaus. Nenil, ains savoit canchons faire,
Partures et motes entés;
De che fist-il a grant plentés,
Et balades, je ne sai quantes.

The eulogist of the renowned *trouwe*, in these lines of the prologue to the *Jeu de Robin et de Marion*, does not even mention the older and longer drama, *Le jeu d'Adam*.

With the rising tide of the Renaissance in France, Maître Adam shared the fate of all mediæval writers: his works were entirely forgotten or else misunderstood, ill-judged and despised. In 1581, thirty-two years after Joachim du Bellay's famous pamphlet-programme of the Pléiade, *Défense et illustration de la langue françoise*, the antiquarian and historian Claude Fauchet wrote in his *Recueil de l'origine de la langue et poësie françoise* (p. 196, f.) the following short notice of Adam de la Hale and his drama, *Le jeu d'Adam*, only a few verses of the first part of which he had apparently read:

Adam le Boçv fut d'Arras, et a composé vn petit œuvre, intitulé le Jeu. Il semble qu'ayant aimé les femmes, et se trouuant deceu d'une il se fit clerc, car il dit:

Seignor sauez porquoy i'ai mon habit changié,
J'ai esté ouec fame, or reuois an clergié.

Je croy qu'il se retira à Vaucelles. C'est à luy à qui Jehan Bretel adresse la 14. chanson de Jeuparti. Il dit en son Jeu comme par dialogue:

Onques d'Arras bon clerc n'issi. Puis il respond:
N'est mie Riquiers d'Amiens,
Bon clers et soutiex en son linre.

(Cf. Bahlsten, *Adam de la Hale's Dramen* . . . , p. 218.)

Fanchet's remark, scanty and injudicious, had the good fortune, for nearly two hundred years, of being regarded as authoritative by his colleagues, the critics and littérateurs, who condescended to write on French literature before the Renaissance and to mention Adam de la Hale. This statement is the direct or indirect source of their remarks on the great *trouwe* of Arras, in which they faithfully repeat the very words of Fanchet, sometimes with omissions, and sometimes with slight variations that turn out to be misconceptions and errors. On the whole one may safely say, Adam de la Hale was entirely unknown to the educated classes, and very little known to students and historiographers of literature until the last third of the eighteenth century, and the general opinion of students of literature on the origins of dramatic art in France never rose, during this period, above the naïvely absurd statement in the following verses of the legislator of the French Parnassus, Boileau-Despréaux, in *L'Art poétique* [1674] (Chant III, 81-86):

Chez nos devots Ayeux, le Theatre abhorré
Fut long-temps dans la France un plaisir ignoré.
De Pelerins, dit-on, une Troupe grossiere

En public à Paris y monta la première ;
Et sottement zélée en sa simplicité,
Joïa les Saints, la Vierge et Dieu par pitié.

A new epoch of criticism for the subject in question begins in 1779 with Legrand d'Aussy, who treats of the mediæval drama and Adam d'Arras in the second volume of his work entitled: *Fabliaux ou contes du XII^e et du XIII^e siècle, traduits ou extraits d'après divers manuscrits du tems, avec des notes historiques et critiques, et les imitations qui ont été faites de ces contes depuis leur origine jusqu'à nos jours* (Paris, 1st edition, 4 volumes, 1779-1781; 2nd edition, 5 volumes, 1781; 3rd edition, 1829). This author has the indisputable honor of having been the first to clear up in some measure the obscure beginnings of the profane drama in France, to give to our *trouvère* the place which of right belongs to him as a dramatic poet in French literature, and to analyze with some degree of correctness and sufficient clearness the contents of *Le jeu de Robin et de Marion*. He calls this play *Le jeu du berger et de la bergère*, and adds an analysis also of the first part of *Le jeu d'Adam*, probably the same fragment that Claude Fauchet had in view in his notice of Adam de la Hale, mentioned above. But it was a long time before Legrand d'Aussy's results, verified and rectified by the close researches of a long succession of scholars, came to be acknowledged as established facts worthy the attention of the average littérateur and acceptable to the general reader of literature.

The paper presented before the University Philological Association contains a short but complete history of the critical study of Adam de la Hale's works from the year 1779 up to date. It will suffice to mention in this abstract only a few dates, authors and publications that mark real progress in the development of this study (All writers are omitted who treat exclusively of our *trouvère's* music): Legrand d'Aussy, 1779-1781 (see above); Monmerqué, 1822 and 1828, edition of Adam's dramas in *Mélanges publiés pour la Société des Bibliophiles*, vol. II and VI; Monmerqué and Francisque Michel, 1839, *Théâtre français au moyen âge*; Paulin Paris, 1836, *Encyclopédie Catholique*, vol. II,—1844, *Histoire littéraire de la France*, vol. XX; Charles Magnin, 1834-1835, *Cours publics, Journal de l'Instruction publique et des Cours scientifiques et littéraires*, vol. IV, V,—1838, *Les origines du théâtre moderne*,—1846-1847, *Journal des Savants*; E. de Coussemaker, 1872, *Œuvres complètes du trouvère Adam de la Halle (Poésies et Musique)*; Leopold Bahlsen, 1884 and 1885, *Adam de la Hale's Dramen und das "Jus du pelerin,"* dissertation; L. Petit de Julleville, 1885 and 1886, *Histoire du théâtre en France au moyen âge*, Parts II, III, IV; A. Rambeau, 1886, palæographic edition of *Li jus du pelerin, Li gîens de Robin et de Marion*, and *Li jus Adam*; Alfred Jeanroy, 1889, *Les Origines de la poésie lyrique en France*, and Gaston Paris, 1891-1892, *Compte rendu, Journal des Savants*; Creizenach, 1893, *Geschichte des neuern Dramas*, vol. I; Ernest Langlois, 1895, *Interpolations du jeu de Robin et Marion*, in *Romania* (July), and, in the same year, *Le jeu de Robin et Marion par Adam le Bossu* (a popular edition with introduction, translation, and notes).

AMERICAN AMBER-PRODUCING TREE.

[Reprinted from *Science*, April 17, 1896.]

Up to the present time amber has not been found in North America in commercial quantities, although it is known from a number of widely scattered localities. It appears to have been first reported by Dr. G. Troost, from Cape Sable, Magothey River, Maryland, in 1821.¹ It has also been found in small quantities near Cañon Diablo, Arizona; near the Black

¹ Am. Jour. Sci., Vol. III, 1821, pp. 8-15.

Hills, in South Dakota; Gay Head, on Martha's Vineyard; Trenton and Camden, New Jersey; Chesapeake and Delaware Canal, and a number of more or less doubtful localities.

The Cape Sable locality has been visited several times recently by Mr. Arthur Bibbins, instructor in geology in the Woman's College of Baltimore, and a careful search made for the amber.

This place is somewhat difficult of access from Baltimore, and the visits to it were made possible by the courtesy of Dr. R. W. L. Rasin, of Baltimore, who placed his commodious tug at Mr. Bibbins' disposal for the investigation.

A number of small pieces of amber were found *in situ* in thin strata composed largely of comminuted lignite. By careful excavation Mr. Bibbins was able to expose a log of lignite which showed in several cases the amber in its interstices. Through the kindness of Mr. Bibbins I have been enabled to investigate the structure of this amber-producing tree.

This log was found about twenty feet below the surface in strata provisionally regarded by Mr. Bibbins as of upper Potomac (upper part of Lower Cretaceous) age. About four feet in length of the log was taken out. It was very soft when excavated and hardly to be distinguished from the surrounding matrix. When dried by exposure to the air it becomes thoroughly disintegrated into minute fragments, and even when treated by hardening substances still retains so much iron pyrites that it appears impossible to stop its reduction to powder. Before fossilization the log had been completely honeycombed, apparently by a *Teredo*-like mollusk. This condition made its compression easy, and when excavated it was found to be much flattened. It was about fourteen inches in long, and six inches in short diameter.

When observed with the naked eye or with a low-power lens, the wood appears to be admirably preserved. The grain shows very clearly, and when it is split radially, faint traces of the medullary rays can be made out. It is very soft and may be sliced with an ordinary razor without treatment of any kind. But when studied under a compound microscope it is found at once that much disintegration and distortion has taken place. The wood cells have been flattened and crushed until it is quite impossible to make out their character.

This amber-producing tree was of course coniferous, but the poor state of preservation renders its generic determination more or less open to question. The Baltic amber-producing trees, of which some six species are known from studies of the internal structure, were pines (*Pinites*), but no evidence could be found to show that the one under discussion belonged to this group. Indeed, it is hardly to be expected that the genus would have had the same peculiarities from the lower cretaceous to the oligocene, the age to which the Baltic amber belongs. The large resin tubes and compound medullary rays are characters of the pine group, but are absent in this. On the other hand, as nearly as can be made out, the structure is that of *Sequoia* or *Cupressinoxylon*, as the wood is known in the fossil state. It is very much like certain lignites that have been described from the Potomac formation, but of which too little is still known. This view is further strengthened when it is remembered that some fifteen species of *Sequoia* are already known, from the researches of Fontaine, to have lived during Potomac times.

I venture to propose for this American amber-producing tree the provisional name of *Cupressinoxylon? Bibbinsi*, in honor of the collector, who has done so much to elucidate the complex history of the Potomac formation and its vegetation.

F. H. KNOWLTON.

U. S. NATIONAL MUSEUM, WASHINGTON, D. C.

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PROCEEDINGS OF SOCIETIES.

*Scientific Association.**See pp. 90-91 of this Circular.**Philological Association.*

April 17, 1896.—One hundred and fiftieth regular meeting. Professor Warren in the chair. Thirty members present.

Papers read:

The Théâtre Libre, by P. OGDEN.

On Isocrates' Use of *ῥῆμα* as an Index of Style, by W. A. ECKELS.

May 15.—One hundred and fifty-first regular meeting. Professor Warren in the chair. Twenty-four members present.

Papers read:

Maitre Adam d'Arras, by A. RAMBEAU. (*See p. 93.*)The Letter of an Assyrian Princess, by C. JOHNSTON, JR. (*See p. 91.*)*Historical and Political Science Association.*

March 6.

Jefferson's Plans for the University of Virginia, by H. B. ADAMS.

A. McF. Davis on Provincial Banks, by A. C. BRYAN.

Glenn on the Negro in Jamaica, by G. C. LEE.

The Cuban Question in its True Light, reviewed by E. A. SMITH.

Cathedrals of England (with stereopticon), by J. M. VINCENT.

March 20.

Social reunion of the Seminary and invited guests.

April 17.

Causes of the Maryland Revolution of 1689, by F. E. SPARKS.

Edward Carroll's Principles and Practice of Finance, by J. H. HOLLANDER.

Vance on Slavery in Kentucky, by A. F. LEWIS.

Sherwood on the Foreign Policy of the U. S., by C. H. BROUGH.

Maryland Archives, Vol. XIV, reviewed by F. E. SPARKS.

May 1.

Neutrality of the American Lakes, by J. M. CALLAHAN.

Dennis on Lord Baltimore's Struggle with the Jesuits, by J. A. C. CHAYDLER.

Lord Acton's Inaugural Address, by G. B. LYNES.

C. F. Adams on the Battle of Bunker Hill, by C. A. ADAMS.

Carry on the Education of the Negro, by F. ANDREWS.

Education in the South, by E. W. SIKES.

May 22.

The History of Higher Education in Kentucky, by A. F. LEWIS.

University Extension and the Historical Seminary, by J. M. VINCENT.

Catholic Historical Researches, by C. P. NEILL.

Schultz on the Germans in Maryland,

Publications of the Jewish Historical Society, Vol. IV, } by M. REIZENSTEIN.

Materials for Northwestern History, by J. M. CALLAHAN.

Seeley's Growth of British Policy, by J. R. EWING.

Mathematical Seminary.

Conducted by Professor CRAIG.

February Meetings.—W. M. MCCLAIN, Director.

February 19 and 26.—Theory of Surfaces, by J. G. HARDY and O. SCHMIEDEL.

March Meetings.—J. G. HARDY, Director.

March 4, 11, 18, and 25.—Theory of Surfaces, by N. A. PATTILLO, T. E. MCKINNEY, E.

R. DUVALL, and W. M. MCCLAIN.

April Meetings.—A. PELL, Director.

April 15, 22, and 29.—Theory of Surfaces, by A. PELL, J. G. HARDY, and N. A. PATTILLO.

PUBLIC MEETINGS AND SOCIAL ASSEMBLIES

Recently held in the University Buildings.

A reception given by the Young Men's Christian Association of the University in honor of Bishop Vincent, Levering Lecturer, in Levering Hall, March 27.

A meeting commemorative of the late Mr. John Glenn, of Baltimore, held in Levering Hall, April 4.

A meeting to further the organization of the Edgar Allen Poe Memorial Association, in the Donovan Room of McCoy Hall, April 15.

A reception given by the Baltimore Branch of the Archaeological Institute of America, April 24, in the Donovan Room of McCoy Hall, in honor of Professor Warren. In view of his approaching departure for Rome, where he is to be Director, for 1896-97, of the American School of Classical Studies, the evening was devoted to Roman Archaeology. Mr. G. J. Laing, Fellow in Latin, gave an account of Piranesi and his work; Professor K. F. Smith presented a brief notice of the Gallus Inscription recently discovered in Egypt; and Professor Warren made an address upon the work of the new School in Rome. A number of pictures, chiefly from the great works of Piranesi, were placed on exhibition for the evening.

A reception given by the Graduate Students' Association in honor of Professor George Adam Smith, the Turnbull Lecturer for 1896, in McCoy Hall, April 28.

A meeting of the Phi Beta Kappa Society, Alpha Chapter of Maryland, April 28, in the Donovan Room of McCoy Hall, followed by a banquet.

A special meeting of the Charity Organization Society of Baltimore, in Levering Hall, May 21, followed by a reception in honor of Mr. C. S. Loch, Secretary of the Charity Organization Society of London, Eng.

CONFERRING OF DEGREES.

The public exercises connected with the conferring of degrees were held in the Lyceum Theatre, June 11, at 4 p. m.

The order of exercises was as follows:

Prelude: The Coronation March from "Die Folkunger," by Kretschmar.

I. Music, Largo, *Händel*.

II. Prayer. Rev. Dr. LEAKIN.

III. Music, "Veritas vos liberabit," *Starr*.

IV. Address by the President of the University.

V. Music, Polish Dances, *Scharwenka*.

VI. Presentation of the Candidates: Bachelors of Arts, by Professor GRIFFIN. Proficients in Applied Electricity, by Professor DUNCAN. Doctors of Philosophy, by Professor REMSEN. CONFERRING OF DEGREES.

VII. Music, Presto from Suite "Jeux d'enfants," *Bizet*.

VIII. Congratulatory Address by the President of the Board of Trustees, C. MORTON STEWART, Esq.

IX. Music, Allegro moderato, from "Scenes pittoresques," *Massenet*.

X. ANNOUNCEMENT OF HONORS AND PRIZES.

XI. Music.

The orchestra was under the direction of Mr. W. E. Heimendahl.

ADDRESS OF PRESIDENT GILMAN.

The principal address was given by President Gilman. He reviewed the efforts that have been made in Maryland for the promotion of education from the earliest colonial times to the present day, and dwelt upon the opportunities that Baltimore now has. His opening remarks were as follows:—

If any one in this assembly has reason to be proud and happy on this festal day, more proud and happy, if that be possible, than these candidates for academic honors, it is the President of the Johns Hopkins University. The circumstances under which I speak to you are so unusual that I am sure you will pardon the personal allusions I am about to make.

Not many days ago, as you are well aware, I was urgently requested to say that I would accept, if it were offered, an educational post of unique importance in the City of New York, and for a brief period I was subjected to an amount of pressure which can never be publicly known. With the result you are acquainted, but you do not know, nor can I tell you, how in an hour of solicitude and doubt I was surprised and rewarded and encouraged by your kind expressions. I cannot be too grateful to the Trustees, the Faculty, the Alumni, the Students, and to many honored citizens of Baltimore for their words of confidence,—assurances so spontaneous and hearty that doubt and hesitation respecting the path of duty at once disappeared. The memory of such kindness is a life-long possession, demanding renewed consecration to the advancement of knowledge and the education of youth.

But as general interests transcend individual concerns, this is time for more than personal acknowledgments. The University must speak out, and speak to the public.

Out of our recent misfortunes, the best of good fortune seems to be forthcoming. Unless the signs mislead us, Baltimore has now adopted the Johns Hopkins University. Having watched its infancy and early manhood; having felt its influence; having observed its contributions to science and literature; having shared in its renown; Baltimore now says, in words that are golden, "Go on with increasing vigor and we will support you." A letter which I hold in my hand restrains me from naming the individuals to whom such encouraging words are attributed. But time will take care of that; their deeds will not be forgotten. At the moment, without the personal acknowledgments which are deferred and not omitted, the University returns its thanks to the contributors of every name, and of any amount, for their timely help.

Certain characteristics of the subscription which has recently been made are noteworthy. Many of the contributors are those who have made generous gifts before. A few know the University only by name. All the great religious bodies in this community are represented among the donors. The young men of this community, including many who have been trained within our walls, have come forward with genuine enthusiasm. Many of the parents of present and former students have made generous gifts. The action of the Alumni of the Baltimore City College is one of the most gratifying of all the incidents of the fortnight. All these efforts have been sup-

ported by the newspapers of Baltimore with generous words, and more than that with manly deeds, as generous as they were prompt.

The best of all signs is this. Some of our far-sighted friends perceive that large accessions should be made to our capital, and one gentleman of high financial standing has proposed that measures be taken to secure a generous permanent endowment. I have been assured that another citizen stands ready to second this movement. Others, mindful of the aid which is given in other States to higher education, go so far as to say that the time has come for the State of Maryland to do its part.

All this marks an epoch in our history. In return for it, the University owes to the public renewed activity and vigor. Already some measures have been adopted which are likely to be fruitful. Early in the next session the University will invite a committee of citizens to visit the libraries, lecture rooms, laboratories, and to report their observations and suggestions. Some will be chosen because of their ability in financial affairs; some because of their love for books; some because they are interested in the progress of modern sciences; some for their knowledge of medicine; some because they know the needs of Maryland; some because they know the South; and some, let me add, because they love athletic sports. To such a committee as that, the fullest statements will be presented respecting the finances and investments, and also concerning opportunities, difficulties and encouragements of every department of the University.

Secondly: The Trustees desire to offer certain courses of lectures, especially in literature, history, economics, and education, to properly qualified hearers, whether men or women, who may not be enrolled as students, but may be desirous of profiting by opportunities here given for advanced instruction.

Thirdly: The recent action of the Legislature in establishing a State Geological Survey will enable some of the teachers of the University to visit every part of the State, and to hold meetings which will tend to awaken an interest in the development of the natural resources of the State, and likewise in all that tends to its social progress.

Fourthly: Whenever the funds are provided it is important that a new building should be constructed to contain collections in botany, zoölogy, and geology, in historical documents, and in rare books. With this there should be a good auditorium.

Fifthly: A large expansion should be given to the department of Electricity.

Sixthly: Ample provisions should be made for the encouragement of athletic sports.

Seventhly: Large additions should be made to the staff of professors.

The President and Faculty received the graduates of the year and their friends, in McCoy Hall, at half-past eight o'clock.

PRESIDENT GILMAN'S LETTER ON THE SUPERINTENDENCY OF SCHOOLS IN NEW YORK.

The name of President Gilman was publicly mentioned, during the last few days in the month of May, in connection with the appointment of a Superintendent of Schools in the city of New York. The following statement which was presented to the Board of Education in that city, Thursday evening, May 28, explains his relation to the proposal.

On Monday of last week, May 18th, I received a friendly, unofficial request that I would allow my name to be presented to the consideration of the Board of Education in the city of New York, for the office of Superintendent of Schools. The suggestion took me absolutely by surprise; but it was presented in such a way that I did not see how I could say "no." It was made apparent to me that the position referred to is, to-day, one of the most important positions, if not the most important, in American education. I still think so, and for these reasons.

The great city, soon to be "Greater New York," with its enormous outlays for schools, has secured, through the influence of a Committee of one hundred representative citizens, a new law permitting, in many respects, the re-organization of its system of public instruction. An opportunity like this for the introduction of modern methods, adapted to the requirements of all classes in the community has never, so far as I am aware, occurred before.

I should consider it a privilege and an honor to take a responsible part in a work of such magnitude and of such far-reaching influences, for surely the improvement of schools in the metropolis would be for the advantage of the whole country and the whole world. The studies and observations of a life devoted to the advancement of education could not be directed to a nobler object.

Among the problems that are now of paramount interest, is the permanent separation of the public school system from the influences of parties, sects, and personal preferments. Again there is the world-wide question of our times—how can old methods of instruction be improved, and the training of the eye and hand be secured without the neglect of the printed page? How may morality and patriotism be promoted in schools that are governed by local self-government and are free from the control of all religious bodies? How may the different requirements of such diverse elements as constitute the population of a cosmopolitan city be wisely and economically supplied? What is the proper training for public school teachers? These and other problems will be solved in New York, primarily for its own advantage, but likewise also as an example to every other city of the land.

Such considerations led me to consent to the presentation of my name last Wednesday; no election followed and action was postponed for a week and a day. In the interval that has followed, remonstrances, far stronger than I foresaw, have been made against my acceptance of the post. This resistance culminated in the action of the authorities of the University, who informed me last Saturday, officially, in explicit terms, that my departure at this time from the post that I hold, would be regarded by them as "a calamity," and that I would "not be permitted to leave" this institution. This action was made public at once. Under these circumstances, it is my final and deliberate request that no further consideration be given to my nomination, and that my friends do not present my name.

No fear of work, no question of compensation, no dread of interference has affected a decision which is reached on grounds of public duty alone.

I ask leave to add an expression of gratitude to those who have advocated my appointment. I cannot tell them how much I value the honor. I would also express my admiration for the attitude of the journals of New York, which have stood as a united column for the improvement and advancement of the public school system, with suggestions that are full of promise for the future. In my belief, the prosperity of this country, material, intellectual and moral, depends upon the wisdom with which the public schools are maintained. When all the best forces of the metropolis are united for this end, hope and courage will everywhere prevail.

DANIEL C. GILMAN.

BALTIMORE, May 27, 1896.

MARYLAND GEOLOGICAL SURVEY.

A Geological and Economic Survey of Maryland has just been inaugurated by the Legislature of the State and the sum of \$10,000 annually is appropriated for the maintenance of the bureau. By the provisions of the Bill, Governor Lowndes, Comptroller Graham, President Gilman of this University, and President Sylvester of the Maryland Agricultural College, are made the Board of Commissioners. At a meeting of organization on March 25, the Board appointed Prof. Wm. Bullock Clark, State Geologist.

The Survey will be organized immediately and the instructors and students of the Geological Department will carry on the field-work in various portions of Maryland during the summer. Their investigations will be supplemented by others in several lines.

Prominence will be given to studies of the practical and economic questions relating to geology, in order that the people of the State of Maryland may obtain the greatest benefit from the work of the survey. At the same time the scientific investigations will be carried on as a basis for these studies and for their educational importance.

The subject to be first considered will be that of building-stones, and a thorough investigation of this subject, so important to the material prosperity of the State, will be made. Later, materials for road construction, coal, iron, clays, marls, and the other varied mineral products of the State will be treated. The data for a general report upon the geology of the several regions of the State will be gradually collected.

The Act under which the Survey is established is as follows:—

"An Act to establish a State Geological and Economic Survey, and to make provision for the preparation and publication of reports and maps to illustrate the natural resources of the State, together with the necessary investigations preparatory thereto."

Section 1. Be it enacted by the General Assembly of Maryland, That there is hereby established a State Geological and Economic Survey which shall be under the direction of a commission composed of the Governor, the Comptroller, the president of the Johns Hopkins University and the president of the Maryland Agricultural College, who shall serve without compensation, but shall be reimbursed for actual expenses incurred in the performance of their official duties; and the said commissioners shall have general charge of the survey, and shall appoint as superintendent of the same a geologist of established reputation, and upon his nomination such assistants and employees as they may deem necessary; and they shall also determine the compensation of all persons employed by the survey, and may remove them at pleasure.

Sec. 2. And be it enacted, That the survey shall have for its objects:

(1.) An examination of the geological formations of the State, with special reference to their economic products, viz.: buildings, stones, clays, ores and other mineral substances.

(2.) An examination and classification of the soils and a study of their adaptability to particular crops.

(3.) An examination of the physical features of the State with reference to their practical bearing upon the occupations of the people.

(4.) The preparation of special geological and economic maps to illustrate the resources of the State.

(5.) The preparation of special reports, with necessary illustrations and maps, which shall embrace both a general and detailed description of the geology and natural resources of the State.

(6.) The consideration of such other scientific and economic questions as in the judgment of the commissioners shall be deemed of value to the people of the State.

Sec. 3. And be it enacted, That the commissioners shall cause to be prepared a report to the Legislature before each meeting of the same, showing the progress and condition of the survey, together with such other information as they may deem necessary and useful or as the Legislature may require.

Sec. 4. And be it enacted, That the regular and special reports of the survey, with proper illustrations and maps, shall be printed as the commissioners may direct, and that the reports shall be distributed or sold by the said commissioners as the interest of the State and of science demands, and all moneys obtained by the sale of the reports shall be paid into the State treasury.

Sec. 5. And be it enacted, That all material collected, after having served the purposes of the survey, shall be distributed by the commissioners to the educational institutions in such manner as to be of the greatest advantage to the educational interests of the State; or, if deemed advisable, the whole or a part of such material shall be put on permanent exhibition.

Sec. 6. And be it enacted, That the sum of ten thousand dollars annually, or so much thereof as may be necessary, is hereby appropriated out of any funds of the treasury not otherwise appropriated, for the purpose of carrying out the provisions of this Act.

Sec. 7. And be it further enacted, That this Act shall take effect from the date of its passage.

THE OPENING OF THE DILLMANN LIBRARY.

The birthday of Professor Dillman and the reopening of his library, now arranged in McCoy Hall, was celebrated by an assembly of persons interested in Biblical Literature and Oriental Philology, on Saturday evening, April 25. As before announced, this collection has been presented to the University by Mr. G. W. Gail, of Baltimore. It contains 2,318 bound volumes and 2,222 pamphlets. It has been classified and suitably arranged in the Semitic Seminary room. The principal address was by Professor Haupt, reviewing the life and works of Professor Dillmann. Brief addresses were also made by President Gilman, Mr. Gail, and Professor G. A. Smith.

A lecture was given in Levering Hall, May 1, by Rev. Dr. ARTHUR J. MASON, Canon of Canterbury Cathedral, England, on "Life in the Church during the Third Year after the Ascension."

HON. GARDINER G. HUBBARD, of Washington, gave an exhibition (with the aid of the stereopticon) of engravings illustrative of the life of Napoleon Bonaparte, in McCoy Hall, April 1.

Dr. JAMES CAREY THOMAS and Professor AMES were designated as Delegates to represent this University at the celebration of the Jubilee of Lord Kelvin, in Glasgow, June 15 and 16.

President GILMAN will represent the Johns Hopkins University at the celebration of the one hundred and fiftieth anniversary of the founding of the College of New Jersey, and the inauguration of Princeton University, in October 1896. Professor REMSEN will also be present as a delegate from the National Academy of Sciences.

The University has been invited by the Geographical Society of Lisbon to send a delegate to the celebration, in July 1897, of the four hundredth anniversary of the discovery by Vasco da Gama of the maritime route to the Indies, and Professor A. M. ELLIOTT has been so designated.

Mr. F. S. CONANT, Fellow in Biology, and Mr. H. L. CLARK, University Scholar, have gone to Kingston Harbor, Jamaica, under the auspices of the University, to prosecute researches in Marine Zoology.

AT THE RECENT COMMENCEMENT of the Law Department of the University of Maryland, the following graduates and former students of the Johns Hopkins University received the degree of LL. B.:

Robert Burton (Special Student, 1892-93), M. S. Cohen (A. B., 1894), Eli Frank (A. B., 1894), LeRoy Gresham (Graduate Student, 1893-94), R. B. Harvey (A. B., 1895), John Phelps (Matriculate, 1891-92), S. H. Stein (A. B., 1894), M. V. Tyson (A. B. 1894), P. L. Wickes, Jr. (A. B., 1894).

The prize for the best scholarship during the course and also the prize for the best thesis were awarded to Eli Frank.

AMERICAN CHEMICAL JOURNAL.

CONTENTS OF VOLUME XVIII, No. 6.

On the Specific Gravities of Mixtures of Normal Liquids. By C. E. LINEBARGER.

Contributions from the Chemical Laboratory of Cornell University:—

XCIV. Dianthranol—A Dihydroxyl Derivative of Dianthracene. By W. R. ORNDORFF and C. L. BLISS.

Contribution from the Chemical Laboratory of Harvard College:—

Bromine Derivatives of Metaphenylene Diamine. By C. LORING JACKSON and SIDNEY CALVERT.

Contribution from the Kent Chemical Laboratory of the University of Chicago:—

On Benzimidazole and Benzimidomethyl Ethers. By F. W. BUSHONG.

On the Halogen Derivatives of the Sulphonamides. By J. H. KASTLE, B. C. KEISER, and EARNEST BRADLEY.

The Reduction of Copper Sulphide. By DELIA STICKNEY.

Reviews and Reports.

AMERICAN JOURNAL OF PHILOLOGY.

CONTENTS OF VOLUME XVI, No. 4.

On Assimilation and Adaptation in Congeneric Classes of Words. By MAURICE BLOOMFIELD.

The Song of Songs Again. By RUSSELL MARTINEAU.

Establishment and Extension of the Law of Thurneysen and Havet. By LIONEL HORTON SMITH.

The Codex Riccardianus of Pliny's Letters. By ELMER TRUESDELL MERRILL.

Notes, Reviews and Book Notices, Correspondence, Reports.

AMERICAN JOURNAL OF MATHEMATICS.

CONTENTS OF VOLUME XVIII, No. 2.

On the Inclination Terms in the Moon's Coordinates. By P. H. COWELL.

On Non-uniform Convergence of Infinite Series. By A. S. CHESSIN.

On a Certain Class of Equipotential Surfaces. By B. O. PEIRCE.

Remarques sur les Équations de Dynamique et sur le mouvement tautochrone. Par M. MICHEL PETROVITCH.

Note on C. S. Peirce's Paper on "A Quincuncial Projection of the Sphere." By JAMES PIERPONT.

On the Invariance of the Factors of Composition of a Substitution-group. By JAMES PIERPONT.

The Representation of Finite Groups, especially of the Rotation Groups of the Regular Bodies of Three- and Four-Dimensional Space, by Cayley's Color-Diagrams. By H. MASCHKE.

DEGREES CONFERRED AND APPOINTMENTS AND HONORS ANNOUNCED, JUNE 11, 1896.

DEGREES CONFERRED.

DOCTORS OF PHILOSOPHY.

BENJAMIN WILLIAM ARNOLD, JR., of Bedford City, Va., A. B., Randolph Macon College, 1891. *Subjects*: Economics, Mathematics, and Philosophy. *Thesis*: History of the Tobacco Industry in Virginia from 1860 to 1894.

Referees on thesis: Professor Sherwood and Dr. Hollander.

GEORGE MELVILLE BOLLING, of Baltimore, A. B., Loyola College, 1891. *Subjects*: Greek, Sanskrit, and Latin. *Thesis*: The Participle in Hesiod. *Referees on thesis*: Professors Gildersleeve and Spieker and Dr. Miller.

FERDINAND BONNOTTE, of Baltimore, Collège Louis-Le-Grand, Paris. *Subjects*: French, Italian, and History. *Thesis*: Phonologie et Morphologie du dialecte picard dans le Laonais et le Soissonnais.

Referees on thesis: Professor Elliott and Dr. Menger.

ALFRED COOKMAN BRYAN, of Rising Sun, Md., A. B., Johns Hopkins University, 1892. *Subjects*: Economics, History, and Social Science. *Thesis*: State Banking in Maryland.

Referees on thesis: Professors Adams and Sherwood.

ARTHUR DOUGLAS CHAMBERS, of Toronto, Ont., A. B., University of Toronto, 1892. *Subjects*: Chemistry, Mineralogy, and Geology. *Thesis*: An Investigation of the Composition of certain Oxides of Manganese.

Referees on thesis: Professors Remsen and Morse.

JULIAN ALVIN CARROLL CHANDLER, of Guiney's, Va., A. B., William and Mary College, 1891. *Subjects*: History, English, and Jurisprudence. *Thesis*: Representation in Virginia.

Referees on thesis: Professors Adams and Vincent and Dr. Steiner.

JAMES WILKINSON CHAPMAN, JR., of Chestertown, Md., A. B., Washington College, 1892. *Subjects*: Economics, History, and Social Science. *Thesis*: State Tax Commissions in the United States.

Referees on thesis: Professor Sherwood and Dr. Hollander.

HENRY SCOTFIELD COOLEY, of Summit, N. J., S. B., University of the City of New York, 1891. *Subjects*: History, Economics, and Philosophy. *Thesis*: A Study of Slavery in New Jersey.

Referees on thesis: Professors Adams and Vincent and Dr. Steiner.

HENRY RUSHTON FAIRCLOUGH, of Stanford University, Cal., A. B., University of Toronto, 1883. *Subjects*: Greek, Latin, and Sanskrit. *Thesis*: Attitude of the Greek Tragedians towards Nature.

Referees on thesis: Professor Spieker and Dr. Miller.

EDSON FESSENDEN GALLAUDET, of Washington, D. C., A. B., Yale University, 1893. *Subjects*: Physics, Electricity, and Mathematics. *Thesis*: Relations between Length, Elasticity, and Magnetization of Iron and Nickel Wires.

Referees on thesis: Professors Rowland and Ames.

FREDERICK STEARNS HOLLIS, of Newton Highlands, Mass., S. B., Massachusetts Institute of Technology, 1890. *Subjects*: Chemistry, Mineralogy, and Geology. *Thesis*: On the two Chlorides of Nitroorthosulphobenzoic Acid.

Referees on thesis: Professors Remsen and Morse.

CHARLES WILLIAM LEVERETT JOHNSON, of Baltimore, A. B., Johns Hopkins University, 1891. *Subjects*: Greek, Latin, and Sanskrit. *Thesis*: Musical Pitch and the Measurement of Intervals among the Ancient Greeks.

Referees on thesis: Professors Gildersleeve and Spieker, and Professor H. W. Parker, of Yale University.

OLIVER MARTIN JOHNSTON, of Bastrop, La., A. B., Mississippi College, 1890. *Subjects*: French, Italian, and History. *Thesis*: Syntactical History of the Atonic Personal Pronouns in Italian.

Referees on thesis: Professor Elliott and Dr. Menger.

FREDERICK ROBERTSON JONES, of Baltimore, A. B., Western Maryland College, 1892. *Subjects*: History, Economics, and Jurisprudence. *Thesis*: History of Taxation in Connecticut, 1636-1776.

Referees on thesis: Professors Adams and Vincent and Dr. Steiner.

HENRY McELDERRY KNOWER, of Baltimore, A. B., Johns Hopkins University, 1890. *Subjects*: Morphology, Physiology, and Botany. *Thesis*: The Embryology of a Termite.

Referees on thesis: Professors Brooks and Andrews.

GORDON JENNINGS LAINO, of Toronto, Ont., A. B., University of Toronto, 1891. *Subjects*: Latin, Greek, and Roman Law. *Thesis*: Expressions of Valuation in Latin.

Referees on thesis: Professors Warren and Smith.

GEORGE LEFEVRE, of Baltimore, A. B., Johns Hopkins University, 1891. *Subjects*: Morphology, Physiology, and Botany. *Thesis*: Budding in Perophora.

Referees on thesis: Professors Brooks and Andrews.

EBENEZER MACKAY, of New Glasgow, N. S., A. B., Dalhousie University, 1886. *Subjects*: Chemistry, Physics, and Mathematics. *Thesis*: A Contribution to the Study of Double Salts in Water Solution.

Referees on thesis: Professors Remsen and Morse.

RAPHAEL MONROE MCKENZIE, of Rahway, N. J., S. B., University of the City of New York, 1890. *Subjects*: Chemistry, Physics, and Mathematics. *Thesis*: Some Double Chlorides of Ferric and of Ferrous Iron with some Aromatic Bases.

Referees on thesis: Professors Remsen and Morse.

HENRY LUDWELL MOORE, of Baltimore, A. B., Randolph Macon College, 1892. *Subjects*: Economics, History, and Jurisprudence. *Thesis*: Von Thünen's Theory of Natural Wages.

Referees on thesis: Professor Sherwood and Dr. Hollander.

FRANKLIN LAFAYETTE RILEY, of Hebron, Miss., A. B., Mississippi College, 1889. *Subjects*: History, Economics, and Jurisprudence. *Thesis*: Colonial Origins of New England Senates.

Referees on thesis: Professors Adams and Vincent and Dr. Steiner.

BRANTZ MAYER ROSZEL, of Baltimore, A. B., Johns Hopkins University, 1889. *Subjects*: Astronomy, Mathematics, and Physics. *Thesis*: The Action of the Asteroids on Mars.

Referees on thesis: Professors Newcomb and Poor.

HERBERT ARMISTEAD SAYRE, of Montgomery, Ala., B. E., University of Alabama, 1893. *Subjects*: Mathematics, Astronomy, and Physics. *Thesis*: On the Generation of Surfaces by the Motion of Plane Curves.

Referees on thesis: Professor Craig and Dr. Hulburt.

FREDERICK GEORGE GOTTLÖB SCHMIDT, of Baltimore, University of Erlangen. *Subjects*: German, English, and Philosophy. *Thesis*: Die Rieser Mundart.

Referees on thesis: Professor Wood and Dr. Vos.

THOMAS STANLEY SIMONDS, of Beverly, Mass., A. B., Harvard University, 1884. *Subjects*: Latin, Sanskrit, and Greek. *Thesis*: The Subjects treated by the Elder Seneca.

Referees on thesis: Professors Warren and Smith.

GEORGE OTIS SMITH, of Skowhegan, Me., A. B., Colby University, 1893. *Subjects*: Geology, Palaeontology, and Chemistry. *Thesis*: The Geology of the Fox Islands, Maine.

Referees on thesis: Professor Clark, Dr. Matthews, and Mr. Bailey Willis.

MICHAEL DRUCK SOHON, of Washington, D. C., A. C., Lehigh University, 1880. *Subjects*: Chemistry, Geology, and Physics. *Thesis*: An Investigation of some Derivatives of Orthosulphobenzoic Acid.

Referees on thesis: Professors Remsen and Morse.

FRANCIS EDGAR SPARKS, of Baltimore County, Md., A. B., Johns Hopkins University, 1893. *Subjects*: History, Economics, and Jurisprudence. *Thesis*: Causes of the Maryland Revolution of 1689.

Referees on thesis: Professors Adams and Vincent and Dr. Steiner.

ARTHUR COE SPENCER, of Cleveland, O., S. B., Case School of Applied Science, 1892. *Subjects*: Geology, Palaeontology, and Biology. *Thesis*: The Geology of Massanutten Mountain in Virginia.

Referees on thesis: Professor Clark, Dr. Mathews, and Mr. Bailey Willis.

THOMAS HARDY TALIAFERRO, of Baltimore, C. E., Virginia Military Institute, 1890. *Subjects*: Mathematics, Physics, and Astronomy. *Thesis*: The Congruences formed by the Tangents to the Lines of Curvature of a given Surface.

Referees on thesis: Professors Craig and Franklin.

JOHN THORNE, of Baltimore, A. B., Denison University, 1885. *Subjects*: Latin, History, and Roman Law. *Thesis*: Syntax and Style of Macrobius.

Referees on thesis: Professors Warren and Smith.

BACHELORS OF ARTS.

THOMAS SEWELL ADAMS, of Baltimore.
 CORNELIUS BEATTY, of Baltimore.
 AUGUSTUS CÆSAR BINSWANGER, of Baltimore.
 CHARLES EDWARD CASPARI, of Baltimore.
 CLARENCE CARROLL CLARK, of Baltimore.
 FRANK WILBUR COLLIER, of Baltimore.
 CHARLES EDWARD DIEHL, of West Virginia.
 WILLIAM REGINALD DORSEY, of Baltimore.
 GEORGE DYRE ELDRIDGE, JR., of Massachusetts.
 ALBERT DALE GANTZ, of Baltimore.
 ALFRED DEARING HARDEN, of Georgia.
 WILLIAM FAITHFUL HENDRICKSON, of Baltimore.
 FRANK HOLMES JOHNSON, of New York.
 CHARLES HARWOOD KNIGHT, of Baltimore.
 WILLIAM KURRELMAYER, of Baltimore.
 ROBERT LACY, of Baltimore.
 HENRY LANAHAN, of Baltimore.
 MONROE LUCHS, of the District of Columbia.
 ARTHUR WEBSTER MACHEN, JR., of Baltimore.
 RICHARD ELLIOTT MARINE, of Baltimore.
 HENRY PICKERING PARKER, of Maryland.
 ALBERT CABELL RITCHIE, of Baltimore.
 LOUIS ROSENBAUM, of Baltimore.
 GLANVILLE YEISLEY RUSK, of Baltimore.
 LAURENCE FREDERICK SCHMECKEBIER, of Baltimore.
 JAMES EUSTACE SHAW, of Italy.
 ST. GEORGE LEAKIN SIOUSSAT, of Maryland.
 ALEXANDER RAYMOND STEVENS, of Baltimore.
 JOHN WESLEY RICHARDSON SUMWALT, of Baltimore.
 JOHN HANSON THOMAS, of Baltimore.
 CHARLES BURNET TORSCH, of Baltimore.
 JAMES MCCONKY TRIPPE, of Baltimore.
 CHARLES WILLIAM WAIDNER, of Baltimore.
 WILLIAM FISHER WALLIS, of Baltimore.
 FREDERICK HOWARD WARFIELD, of Baltimore.
 JOHN ARMISTEAD WELBOURN, of Baltimore.
 JOHN MONTGOMERY WEST, of Baltimore.

(37)

PROFICIENTS IN APPLIED ELECTRICITY.

MATTHEW MAURY CORBIN, of Virginia.
 ISIDOR DEUTSCH, of Baltimore.
 HUGH MILLER FRAZER, of Kentucky.
 JAMES HOLDSWORTH GORDON, JR., of the District of Columbia.
 HORACE MARSHALL HARRIMAN, JR., of Baltimore.
 MALCOLM WESTCOTT HILL, of Baltimore.
 GEORGE HARWOOD HODOES, of Baltimore.
 JASPER ALAN McCASKELL, of Utah.
 GEORGE STEVENS MAYNARD, of the District of Columbia.
 HENRY TODD POWELL, of Baltimore.
 CHARLES LEONARD REEDER, of Baltimore.
 MARTIN SCHWAB, of Baltimore.
 JAMES MOWTON SAUNDERS WARING, of Baltimore.

(13)

APPOINTMENTS AND HONORS.

The following promotions have recently been made by the Trustees:—

FONGER DEHAAN, Ph. D., now Instructor, to be Associate in Romance Languages.
 JACOB H. HOLLANDER, Ph. D., now Instructor, to be Associate in Economics.
 WESTEL W. WILLOUGHBY, Ph. D., now Reader, to be Associate in Political Science.
 THOMAS S. BAKER, Ph. D., now Assistant, to be Instructor in German.
 HENRY L. MOORE, Ph. D., lately Fellow, to be Instructor in Economics.

PRIZES.

John Marshall Prize.

A likeness in bronze of the former Chief Justice of the United States (the gift of a lady in New England), awarded annually for an important contribution to historical and political science published by a graduate student of this University, is awarded to

WESTEL WOODBURY WILLOUGHBY, Ph. D., Associate in Political Science, for his book entitled "The Theory of the State."

C. Morton Stewart Prizes.

The prize of one hundred dollars, offered for the best essay written by a Bachelor of Arts of the Johns Hopkins University of not more than five years' standing, is awarded to JAMES CURTIS BALLAGH (A. B., 1894). The subject of his essay is "Gustavus Adolphus and his Relation to the Thirty Years' War."

The prize of one hundred dollars, offered for the best essay written by any graduate student of the Johns Hopkins University, is awarded to GUY CARLETON LEE, A. B. His essay is on the subject, "The Reign of Frederick Barbarossa."

The first of the two prizes of thirty dollars and twenty dollars respectively, offered for the best essays written by members of the class of 1897, has been awarded to CHARLES KEYSER EDMUNDS, for his essay on "The Character of Benjamin Franklin."

REID HUNT, Ph. D., has the honor of being assigned to the table allotted to this University in the Laboratory of the U. S. Fish Commission, Wood's Holl, Mass.

ADAM T. BRUCE FELLOW.

GEORGE LEFEVRE, of Baltimore, Ph. D., Johns Hopkins University, 1896.

FELLOWS.

EDWARD COOKE ARMSTRONG, of Front Royal, Va., A. B., Randolph Macon College, 1890. *Romance Languages.*

JAMES MORTON CALLAHAN, of Mitchell, Ind., A. B., Indiana University, 1894. *History.*

EDWARD PERKINS CARTER, of Williamstown, Mass., M. D., University of Pennsylvania, 1894. *Pathology.*

HUBERT LYMAN CLARK, of Baltimore, A. B., Amherst College, 1892. *Biology.*

NOAH ERNEST DORSEY, of Annapolis Junction, Md., A. B., Johns Hopkins University, 1893. *Physics.*

PELHAM EDGAR, of Toronto, Ont., A. B., University of Toronto, 1892. *English.*

EDWIN LUTHER GREEN, of Richmond, Va., A. B., Washington and Lee University, 1892. *Greek.*

ARTHUR SEWALL HAGGETT, of New Castle, Me., A. B., Bowdoin College, 1893. *Greek.*

WILLIAM EDWARDS HENDERSON, of Wooster, O., A. B., University of Wooster, 1891. *Chemistry.*

CHARLES HOEING, of Lexington, Ky., A. B., Kentucky State College, 1890. *Latin.*

DUNCAN STARR JOHNSON, of Cromwell, Conn., S. B., Wesleyan University, 1892. *Biology.*

PAUL HENRY LAND, of Baltimore, A. B., Calvin College (O.), 1890. *Semitic Languages.*

OMERA FLOYD LONG, of Millersburg, Ky., A. B., Kentucky Wesleyan College, 1890. *Latin.*

WILLIAM TYLER MATHER, of Amherst, Mass., A. B., Amherst College, 1886. *Physics.*

JOHN FREDERICK MOHLER, of Cumberland County, Pa., A. B., Dickinson College, 1887. *Physics. Resigned, June 12, 1896.*

JENS ANDERSON NESS, of Red Wing, Minn., A. B., Luther College, 1884. *Sanskrit.*

ALEXANDER PELL, of Brooklyn, N. Y., St. Petersburg Artillery School. *Mathematics.*

CORNELIUS WILLIAM PRETTYMAN, of Winston, N. C., A. B., Dickinson College, 1891. *German.*

CHARLES DABNEY RAGLAND, of Hyco, Va., A. B., Randolph Macon College, 1889. *Chemistry.*

FRANK ROY RUTTER, of Baltimore, A. B., Johns Hopkins University, 1894. *Economics*.

GEORGE BURBANK SHATTUCK, of Lowell, Mass., S. B., Amherst College, 1892. *Geology*.

HOPKINS SCHOLARSHIPS.

OFFERED TO VIRGINIA AND NORTH CAROLINA STUDENTS.

These scholarships, in accordance with the wishes of the Founder, are awarded to candidates from Virginia and North Carolina who are considered by the Academic Council to be most deserving of choice because of their character and intellectual promise. They are awarded to college graduates; the Maryland scholarships, elsewhere announced, are given to undergraduates:—

Honorary Scholarships:

J. H. BOWMAN (A. B., Franklin and Marshall, 1893), of Woodstock, Va.
K. CAMPBELL (A. B., William and Mary, 1894), of Enfield, Va.
R. H. GRIFFITH (A. M., Furman, 1892), of Asheville, N. C.
W. F. GILL (A. B., Trinity (N. C.), 1894), of Henderson, N. C.
C. C. HOLDEN (A. B., Johns Hopkins, 1888), of Raleigh, N. C.
W. J. HUMPHREYS (A. B., Washington and Lee, 1886), of Virginia.
G. O. JAMES (A. B., Johns Hopkins, 1895), of Bowers Hill, Va.
W. A. JONES (A. M., Wake Forest, 1894), of Hillsboro, N. C.
J. W. KERN (Univ. of Virginia), of Alexandria, Va.
G. C. LEE (A. B., Dickinson, 1895), of Chapel Hill, N. C.
E. E. REID (A. M., Richmond Coll., 1892), of Lynn Haven, Va.
E. W. SIKES (A. M., Wake Forest, 1891), of Monroe, N. C.

Scholarships:

W. N. BERKELEY (Univ. of Virginia), of Staunton, Va.
F. L. CARR (Ph. B., Univ. of North Carolina, 1895), of Chapel Hill, N. C.
W. B. DANIEL (A. M., Wake Forest, 1892), of Garysburg, N. C.
G. S. FRAPS (N. C. Agricultural College), of Raleigh, N. C.
J. W. GREGG (S. B., Swarthmore, 1894), of Lincoln, Va.
L. C. GLENN (A. B., Univ. of S. C., 1891), of Crowder's Creek, N. C.
E. W. KENNEDY (A. B., Univ. of Tennessee, 1880), of Durham, N. C.
F. MALLORY (C. E., Va. Military Inst., 1889), of Tappahannock, Va.
P. I. MURRILL (A. B., Ky. State Coll., 1895), of Hickory, N. C.
*W. A. MURRILL (A. M., Randolph Macon), of Staunton, Va.
W. A. MONTGOMERY (A. B., Johns Hopkins, 1892), of Warrenton, N. C.
D. P. PARIAM (A. M., Randolph Macon), of Hampton, Va.
G. RYLAND (A. M., Richmond Coll., 1892), of Richmond, Va.
W. SOMMERVILLE (A. B., Hampden Sidney, 1890), of Hampden Sidney, Va.
C. D. M. SHOWALTER (A. B., Milligan College, 1891), of Snowville, Va.
C. B. WILLIAMS (S. B., N. C. Agricultural College, 1893), of Raleigh, N. C.
J. B. WHAREY (A. B., Davidson, 1892), of Davidson, N. C.
R. F. WHITEHEAD (A. M., Univ. of Va., 1893), of Lovings-ton, Va.

* Resigned.

HONORS OF THE UNDERGRADUATES.

The standing of students in the class about to graduate, who are entitled to honors, is as follows:

ARTHUR WEBSTER MACHEN.	LAURENCE F. SCHMECKEBIER.
HENRY LANAHAN.	CORNELIUS BEATTY.
JOHN WESLEY R. SUMWALT.	RICHARD ELLIOTT MARINE.
CHARLES EDWARD CASPARI.	ALBERT CABELL RITCHIE.
WILLIAM KURRELMMEYER.	JAMES EUSTACE SHAW.
{ ST. GEORGE LEAKIN SIOUSSAT.	JAMES MCCONKY TRIPPE.
{ WILLIAM FISHER WALLIS.	MONROE LUCHS.
CLARENCE CARROLL CLARK.	JOHN ARMISTEAD WELBOURN.
THOMAS SEWELL ADAMS.	ALBERT DALE GANTZ.

In accordance with the regulations, University Scholarships are awarded to the first ten students named above, who stand first in point of scholarship.

The standing of students of the second year who are entitled to honors is as follows:

FRANK RINGGOLD BLAKE.	ALFRED HENRY SCHULZ, JR.
DAVID EMBRICH WEGLEIN.	SAMUEL HAMILTON SPRAGINS.
HERBERT MEREDITH REESE.	JOHN EDGAR KNIPP.
CHARLES KEYSER EDMUNDS.	LOUIS MARSHALL WARFIELD, JR.
EUGENE DEFOREST HEALD, JR.	HERBERT HENRY ADAMS.
JOSIAH MORRIS SLEMONS.	WARFIELD THEOBALD LONGCOPE.

The standing of students of the first year who are entitled to honors is as follows:

HAROLD PENDER.	THOMAS FITZGERALD, JR.
JOSEPH NATHAN ULMAN.	VINCENT ADAMS RENOUF.
HENRY JOHN LUKE.	HENRY WIREMAN COOK.
RAYMOND DURBIN MILLER.	JOHN SUMMERVILLE FISCHER.
VICTOR EDGEWORTH SMITH.	THOMAS LINDLEY PYLE.
GUSTAVUS CHARLES DOHME.	ALBERT GAD STIDMAN.
ALEXANDER LAZEAR SETH.	CONWAY SHALER HODGES.

The Hopkins Scholarships, which are awarded to residents of Maryland only, are bestowed as follows:

SECOND YEAR.

Honorary Scholarships:

FRANK RINGGOLD BLAKE.
DAVID EMBRICH WEGLEIN.
HERBERT MEREDITH REESE.

Scholarships:

CHARLES KEYSER EDMUNDS.
JOSIAH MORRIS SLEMONS.

FIRST YEAR.

Honorary Scholarships:

HAROLD PENDER.
JOSEPH NATHAN ULMAN.
HENRY JOHN LUKE.

Scholarships:

RAYMOND DURBIN MILLER.
VICTOR EDGEWORTH SMITH.

The Washington Scholarships are awarded to the following:

EUGENE DEFOREST HEALD, JR. HERBERT HENRY ADAMS.

CONTENTS.

	PAGE.		PAGE.
NOTES FROM THE BIOLOGICAL LABORATORY:		Investigations upon the Electric Discharge in High Vacua. By N. R. CARMICHAEL,	90
Lyell and Lamarck. By W. K. BROOKS, - - - - -	75	The Flow of Glaciers. By H. F. REID, - - - - -	90
Lyell and Lamarckism. By J. T. CONNINGHAM, - - - - -	76	The Letter of an Assyrian Princess. By C. JOHNSTON, - - - - -	91
Lyell. By W. K. BROOKS, - - - - -	78	Maitre Adam d'Arras and the Beginnings of French Comedy. By A. RAMBEAU, - - - - -	93
Budding in Perophora. By W. K. BROOKS and G. LEFEVRE, - - - - -	79	American Amber-Producing Tree. By F. H. KNOWLTON, - - - - -	94
On the Chaetognaths. By F. S. CONANT, - - - - -	82	Proceedings of University Societies, - - - - -	95
On the Anatomy of Yoldia, I. By W. K. BROOKS and G. DREW, - - - - -	85	Public Meetings and Social Assemblies, - - - - -	95
The Development of a Termite. By H. M. KNOWER, - - - - -	86	Conferring of Degrees, - - - - -	95
The Pholadidae, II. By C. P. SINGERFOOS, - - - - -	87	President Gilman's Letter on the Superintendency of Schools in New York, - - - - -	96
The Inhibitory and Accelerator Nerves to the Crab's Heart. By F. S. CONANT and H. L. CLARK, - - - - -	89	Maryland Geological Survey, - - - - -	96
PROCEEDINGS OF THE SCIENTIFIC ASSOCIATION:		Current Notes, - - - - -	97
The Geology of the Cascade Mountains. By BAILEY WILLIS, - - - - -	90	Degrees Conferred, June 11, 1896, - - - - -	98
		Appointments and Honors Announced, June 11, 1896, - - - - -	99

The Johns Hopkins University Circulars are issued monthly. They are printed by Messrs. JOHN MURPHY & CO., No. 44 West Baltimore Street, Baltimore. Subscriptions \$1.00 a year, may be addressed to THE JOHNS HOPKINS PRESS, BALTIMORE; single copies will be sent by mail for ten cents each.

FRANK ROY RUTTER, of Baltimore, A. B., Johns Hopkins University, 1894. *Economics*.

GEORGE BURBANK SHATTUCK, of Lowell, Mass., S. B., Amherst College, 1892. *Geology*.

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J. W. KERN (Univ. of Virginia), of Alexandria, Va.
G. C. LEE (A. B., Dickinson, 1895), of Chapel Hill, N. C.
E. E. REID (A. M., Richmond Coll., 1892), of Lynn Haven, Va.
E. W. SIKES (A. M., Wake Forest, 1891), of Monroe, N. C.

Scholarships:

W. N. BERKELEY (Univ. of Virginia), of Staunton, Va.
F. L. CARR (Ph. B., Univ. of North Carolina, 1895), of Chapel Hill, N. C.
W. B. DANIEL (A. M., Wake Forest, 1892), of Garysburg, N. C.
G. S. FRAPS (N. C. Agricultural College), of Raleigh, N. C.
J. W. GREGO (S. B., Swarthmore, 1894), of Lincoln, Va.
L. C. GLENN (A. B., Univ. of S. C., 1891), of Crowder's Creek, N. C.
E. W. KENNEDY (A. B., Univ. of Tennessee, 1880), of Durham, N. C.
F. MALLORY (C. E., Va. Military Inst., 1889), of Tappahannock, Va.
P. I. MURRILL (A. B., Ky. State Coll., 1895), of Hickory, N. C.
*W. A. MURRILL (A. M., Randolph Macon), of Staunton, Va.
W. A. MONTGOMERY (A. B., Johns Hopkins, 1892), of Warrenton, N. C.
D. P. PARHAM (A. M., Randolph Macon), of Hampton, Va.
G. RYLAND (A. M., Richmond Coll., 1892), of Richmond, Va.
W. SOMMERVILLE (A. B., Hampden Sidney, 1890), of Hampden Sidney, Va.
C. D. M. SHOWALTER (A. B., Milligan College, 1891), of Snowville, Va.
C. B. WILLIAMS (S. B., N. C. Agricultural College, 1893), of Raleigh, N. C.
J. B. WHAREY (A. B., Davidson, 1892), of Davidson, N. C.
R. F. WHITEHEAD (A. M., Univ. of Va., 1893), of Lovington, Va.

* *Resigned.*

HONORS OF THE UNDERGRADUATES.

The standing of students in the class about to graduate, who are entitled to honors, is as follows:

ARTHUR WEBSTER MACHEN.	LAURENCE F. SCHMECKEBIER.
HENRY LANAHAN.	CORNELIUS BEATTY.
JOHN WESLEY R. SUMWALT.	RICHARD ELLIOTT MARINE.
CHARLES EDWARD CASPARI.	ALBERT CABELL RITCHIE.
WILLIAM KURRELMMEYER.	JAMES EUSTACE SHAW.
{ ST. GEORGE LEAKIN SIOUSSAT.	JAMES MCCONKY TRIPPE.
{ WILLIAM FISHER WALLIS.	MONROE LUCHS.
CLARENCE CARROLL CLARK.	JOHN ARMISTEAD WELBOURN.
THOMAS SEWELL ADAMS.	ALBERT DALE GANTZ.

In accordance with the regulations, University Scholarships are awarded to the first ten students named above, who stand first in point of scholarship.

The standing of students of the second year who are entitled to honors is as follows:

FRANK RINGGOLD BLAKE.	ALFRED HENRY SCHULZ, JR.
DAVID EMRICH WEGLEIN.	SAMUEL HAMILTON SPRAGINS.
HERBERT MEREDITH REESE.	JOHN EDGAR KNIPP.
CHARLES KEYSER EDMUNDS.	LOUIS MARSHALL WARFIELD, JR.
EUGENE DEFOREST HEALD, JR.	HERBERT HENRY ADAMS.
JOSIAH MORRIS SLEMONS.	WARFIELD THEOBALD LONOCOPE.

The standing of students of the first year who are entitled to honors is as follows:

HAROLD PENDER.	THOMAS FITZGERALD, JR.
JOSEPH NATHAN ULMAN.	VINCENT ADAMS RENOUF.
HENRY JOHN LUCKE.	HENRY WIREMAN COOK.
RAYMOND DURBIN MILLER.	JOHN SUMMERVILLE FISCHER.
VICTOR EDGEWORTH SMITH.	THOMAS LINDLEY PYLE.
GUSTAVUS CHARLES DOHME.	ALBERT GAD STIDMAN.
ALEXANDER LAZEAR SETH.	CONWAY SHALER HODGES.

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DAVID EMRICH WEGLEIN.
HERBERT MEREDITH REESE.

Scholarships:

CHARLES KEYSER EDMUNDS.
JOSIAH MORRIS SLEMONS.

FIRST YEAR.

Honorary Scholarships:

HAROLD PENDER.
JOSEPH NATHAN ULMAN.
HENRY JOHN LUCKE.

Scholarships:

RAYMOND DURBIN MILLER.
VICTOR EDGEWORTH SMITH.

The Washington Scholarships are awarded to the following:

EUGENE DEFOREST HEALD, JR. HERBERT HENRY ADAMS.

CONTENTS.

	PAGE.		PAGE.
NOTES FROM THE BIOLOGICAL LABORATORY:		Investigations upon the Electric Discharge in High Vacua. By N. R. CARMICHAEL,	90
Lyell and Lamarck. By W. K. BROOKS, - - - - -	75	The Flow of Glaciers. By H. F. REID, - - - - -	90
Lyell and Lamarckism. By J. T. CUNNINGHAM, - - - - -	76	The Letter of an Assyrian Princess. By C. JOHNSTON, - - - - -	91
Lyell. By W. K. BROOKS, - - - - -	78	Maitre Adam d'Arras and the Beginnings of French Comedy. By A. RAMBEAU, - - - - -	93
Budding in Perophora. By W. K. BROOKS and G. LEFEVRE, - - - - -	79	American Amber-Producing Tree. By F. H. KNOWLTON, - - - - -	94
On the Chaetognaths. By F. S. CONANT, - - - - -	82	Proceedings of University Societies, - - - - -	95
On the Anatomy of Yoldia, I. By W. K. BROOKS and G. DREW, - - - - -	85	Public Meetings and Social Assemblies, - - - - -	95
The Development of a Termite. By H. M. KNOWER, - - - - -	86	Conferring of Degrees, - - - - -	95
The Pholadix, II. By C. P. SIGERFOOS, - - - - -	87	President Gilman's Letter on the Superintendency of Schools in New York, - - - - -	96
The Inhibitory and Accelerator Nerves to the Crab's Heart. By F. S. CONANT and H. L. CLARK, - - - - -	89	Maryland Geological Survey, - - - - -	96
PROCEEDINGS OF THE SCIENTIFIC ASSOCIATION:		Current Notes, - - - - -	97
The Geology of the Cascade Mountains. By BAILEY WILLIS, - - - - -	90	Degrees Conferred, June 11, 1896, - - - - -	98
		Appointments and Honors Announced, June 11, 1896, - - - - -	99

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